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OPHTHALMOLOGICAL TRANSACTIONS

VOL. XLI

TRANSACTIONS

OF THE

OPHTHALMOLOGICAL SOCIETY

OF THE

UNITED KINGDOM

WITH WHICH ARE AFFILIATED THE

OXFORD OPHTHALMOLOGICAL CONGRESS
MIDLAND OPHTHALMOLOGICAL SOCIETY
NORTH OF ENGLAND OPHTHALMOLOGICAL SOCIETY
IRISH OPHTHALMOLOGICAL SOCIETY
SCOTTISH OPHTHALMIC CLUB
OPHTHALMOLOGICAL SOCIETY OF EGYPT

VOL. XLI

SESSION 1921

WITH

LIST OF OFFICERS, MEMBERS, ETC.

LONDON
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1921

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Proceedings, Ophthalmic Section, Royal Society of Medicine.
Revue générale d'Ophtalmologie.
Transactions of the American Ophthalmological Society.

NOTICE.

The present volume comprises the proceedings of the Ophthalmological Society of the United Kingdom during its Forty-first Session, May, 1921, together with the reports of the proceedings of the Affiliated Societies, 1920–1921.

The Society does not hold itself responsible for the statements, reasonings, or opinions expressed in the communications which the Council has deemed suitable for publication.

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OF THE

Ophthalmological Society of the United Kingdom

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THE ANNUAL GENERAL MEETING, MAY 7TH, 1921.

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(FROM ITS FORMATION).

ELECTED	
1880	SIR WILLIAM BOWMAN, Bart., LL.D., F.R.S.
1883	SIR JONATHAN HUTCHINSON, F.R.S.
1886	JOHN WHITAKER HULKE, F.R.S.
1889	JOHN HUGHLINGS JACKSON, M.D., LL.D., F.R.S.
1890	HENRY POWER.
1893	D. ARGYLL ROBERTSON, M.D.
1895	EDWARD NETTLESHIP, F.R.S.
1897	SIR HENRY R. SWANZY.
1899	SIR ANDERSON CRITCHETT, Bart., K.C.V.O.
1901	DAVID LITTLE, M.D.
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1905	PRIESTLEY SMITH, M.B.
1907	MARCUS GUNN.
1909	SIR GEORGE BERRY, M.B., LL.D.
1911	J. B. LAWFORD, M.D., LL.D.
1913	F. RICHARDSON CROSS, M.B., LL.D.
1915	W. H. H. JESSOP.
1917	E. TREACHER COLLINS.
1918	J. B. STORY, M.B.
1920	J. HERBERT FISHER, M.B.

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W. T. HOLMES SPICER.
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ELECTED	
1884	SIR JONATHAN HUTCHINSON, F.R.S.
1885	J. HUGHLINGS JACKSON, M.D., LL.D., F.R.S.
1886	PROF. ZEHENDER (Rostock).
1887	HENRY POWER.
1888	SIR HENRY R. SWANZY.
1889	PROF. HANSEN GRUT (Copenhagen).
1890	J. W. HULKE, F.R.S.
1892	PROF. LEBER (Heidelberg).
1893	T. PRIDGIN TEALE, F.R.S.
1895	SIR W. R GOWERS, M.D., F.R.S.
1896	PROF. SNELLEN (Utrecht).
1898	PRIESTLEY SMITH.
1900	R. MARCUS GUNN.
1902	PROF. E. FUCHS (Vienna).
1904	SIR F. W. MOTT, K.B.E., M.D., F.R.S.
1907	PROF. SATTLER (Leipzig).
1909	EDWARD NETTLESHIP, F.R.S.
1911	E. LANDOLT, M.D. (Paris).
1914	PROF. W. UHTHOFF (Breslau).
1917	SIR GEORGE BERRY, M.B., LL.D.
1919	DR. V. MORAX (Paris).
1921	E. TREACHER COLLINS.

EDWARD NETTLESHIP PRIZE.

1904	PRIESTLEY SMITH, M.B.
1907	JOHN HERBERT PARSONS, C.B.E., F.R.S.
1909	EDWARD NETTLESHIP, F.R.S.
1912	GEORGE COATS, M.D.
1915	EDWARD TREACHER COLLINS.
1918	GORDON M. HOLMES, C.M.G., C.B.E., M.D.

*** *Members are requested to communicate with the Council's Secretary when corrections are necessary.*

LIST OF MEMBERS OF THE SOCIETY.

Honorary Members.

Professor E. Fuchs, Vienna.
Professor Sattler, Leipzig.
E. Landolt, M.D., Rue de Berri, 8, Paris.
Professor Gullstrand, Upsala, Sweden.
Dr. V. Morax, Boulevard Raspail, 26, Paris.

EXPLANATION OF ABBREVIATIONS.

O.M.—Original Member.
Pres.—President.
V.-P.—Vice-President.
T.—Treasurer.
L.—Librarian.
S.—Secretary.
C.—Member of Council.
*.—Denotes Resident Life Members.
†.—Denotes Non-Resident Life Members.

GENERAL LIST OF MEMBERS.

ELECTED

1905 Adams, P. E. H., M.B., 53, Broad Street, Oxford.
1912 Alexander, G. F., M.B., 35, Prince of Wales Terrace, Scarborough.
1907 Allport, Wilfred, M.B., 95, Cornwall Street, Birmingham.
1899 †Amenabar, Daniel, Casilla 699, Santiago, Chili
1910 Angelucci, Prof., 2, Piazza N. Amore, Naples.
1913 Anklesaria, M. Dhanjishaw, Ahmedabad, India.
1891 †Armstrong, Hugh, Hobart, Tasmania.
1895 Attlee, John, M.D., 65, Grosvenor Street, W. 1.

ELECTED

1903 Ballantyne, A. J., M.D., 11, Sandyford Place, Glasgow. (C. 1914–17.)

1907 Bardsley, Percy C., M.B., 67, Wimpole St., W. 1.

O.M. *Barlow, Sir Thomas, Bart., K.C.V.O., M.D., 10, Wimpole Street, W. 1. (C. 1880-81. V.-P. 1894-7.)

1920 Barradah, Hassam, P.M.O., Ophthalmic Hospital, Sohag, Egypt.

1889 †Barrett, Sir James W., K.B.E., C.B., C.M.G., M.D., 34, Collins Street East, Melbourne, Australia.

1917 Barrie, T. Stewart, M.B., 13, Somerset Place, Sauchiehall Street, Glasgow.

1920 Barton, Maurice H., 27, Horse Fair Street, Leicester.

1892 Batten, Rayner D., M.D., 9, Wimpole Street, W. 1. (C. 1905-8.)

1888 *Beaumont, W. M., 4, Gay Street, Bath. (V.P. 1912–15. C. 1901-4.)

1912 Beedham, Henry Wm., M.B., 15, Crediton Hill, West Hampstead, N.W. 6.

1891 †Bennett, Alfred H., 16, North Terrace, Adelaide, South Australia.

1897 Bennett, H. Percy, M.B., 12, Victoria Square, Newcastle-on-Tyne.

1905 Bennett, F. D., M.D., 18, Savile Row, W. 1.

O.M. Berry, Sir George A., LL.D., M.B., 31, Drumsheugh Gardens, Edinburgh. (*Pres.* 1909-11. C. 1889-92. V.-P. 1895-8. 1912.)

1899 Bickerton, R. E., D.S.O., M.B., 137, Harley Street, W. 1.

1881 *Bickerton, T. H., 88, Rodney Street, Liverpool. (C. 1895-8. V.-P. 1910-12.)

1905 Bird, J. W., D.S.O., 21, Great St. Andrew Street, Shaftesbury Avenue, W.C. 2.

1892 Black, John Wilson, M.D., 46, Academy Street, Inverness.

1919 Blair, C. J. S., 51, Sheen Road, Richmond.

1898 Blair, Charles Samuel, M.D., 14, Welbeck Street, W. 1.

ELECTED

1917 Bodkin, Herbert, 4, Mutual Buildings, Maitland Street, Bloemfontein, O.F.S., South Africa.

1895 †Bonar, Thomson, M.D., "Glenview," Colinton, Midlothian.

1907 Bond, C. Shaw, M.B., Liphook, Hants.

1911 Boucher, R. B., M.D., Vancouver, B.C.

1885 Bower, Ernest Dykes, M.D., Elton House, Gloucester.

1897 Bower, John A., M.B., 18, Royal Crescent, Cheltenham.

1905 Brailey, A. R. (C.), 24, Harley Street, W. 1.

1902 *Brailey, Wm. Herbert, M.D., 21, Lansdowne Place, Hove, Sussex.

1911 Brearley, E. A., M.B., 141, Macquarie Street, Sydney, N.S.W.

1911 Brennard, . T. W., University Club, Sydney, N.S.W.

1899 Brewerton, Elmore, 73, Harley Street, W. 1. (C. 1909–10; 1914–17. S. 1910-13.)

1920 Bride, T. Milnes, M.D., 26, St. John Street, Manchester.

1903 Brinton, A. G., Box 5852, Johannesburg, South Africa.

1909 Broachâ, B. B., Karachi Eye Hospital, Karachi, India.

1886 Bronner, Adolph, M.D., 33, Manor Row, Bradford. (C. 1900–3.)

1901 *Brooks, R. Philip, 14, Welbeck Street, W. 1.

1895 Browne, Sir J. Walton, M.D., 10, College Square North, Belfast.

1901 Buchanan, Leslie, 8, Royal Crescent West, Glasgow.

1907 Buckland, Francis, M.D., Moorland Court, Poole Road, Bournemouth.

1907 Burdon-Cooper, J., M.D., 12, The Circus, Bath.

O.M. †Burnham, G. H., M.B.

1909 Butler, T. Harrison, M.D., B.Ch. (C.), 26, Adelaide Road, Leamington.

1902 Buzzard, E. Farquhar, M.D., 78, Wimpole Street, W. 1. (C. 1908-9. S. 1909-12.)

1897 †Byers, W. Gordon M., M.D., 346, Mountain Street, Montreal.

ELECTED

1892 †Caiger, Herbert, M.B., 387, Glossop Road, Sheffield.

1905 Campbell, C. A. (Address uncommunicated.)

1891 Campbell, E. Kenneth, M.B., 23, Wimpole Street, W.1.

1891 Cargill, L. Vernon, 35, Cavendish Square, W. 1. (C. 1905-8.)

1921 Carruthers, J. Ferguson, M.D., Royal Herbert Hospital, Woolwich, S.E. 18.

1911 Chambers, W. J., 285, Lander Avenue, Toronto, Canada.

1885 Clarke, Ernest, M.D., B.S., 3, Chandos Street, Cavendish Square, W. 1. (C. 1893-6. V.-P. 1910-12.)

1911 Clegg, John Gray, M.D. (C.), 22, St. John Street, Manchester.

1905 Clements, E. C., 3, Lindum Road, Lincoln.

1907 Cobbledick, Arthur Stanley, M.D., B.S., 21, Bolton Street, Mayfair, W. 1.

1919 Cohen, Louis David, 200, Willis Street, Wellington, New Zealand.

1885 Collins, E. Treacher, 17, Queen Anne Street, W. 1. (*Pres.* 1917-18. V.-P. 1905-8; 1916-17; 1918-21. C. 1889-92; 1901-4. S. 1898-1901.)

1886 Collins, Sir W. J., K.C.V.O., M.S., M.D., 1, Albert Terrace, Gloucester Gate, Regent's Park, N.W. 1.

1920 Conway, James A., M.D., 337, Bath Street, Glasgow, W.

1901 Cooke, Arthur, M.B., Grove Lodge, Cambridge.

1901 Cooper, Ludford, M.D., 16, Star Hill, Rochester, Kent.

1894 †Coote, Patrick, M.D., 73, St. Ann Street, Quebec, Canada.

1914 Coppez, Henri, M.D., 24 Avenue des Arts, Brussels.

1921 Coppinger, Lieut.-Col. W. V., D.S.O., M.D., I.M.S., 6, Little Russell Street, Calcutta.

1904 Corbett, W. J., 18, Weymouth Street, W. 1.

1921 Cormack, Capt. H. S., M.C., I.M.S., M.B., c/o Messrs. Grindlay & Co., Parliament Street, London, S.W. 1.

1898 Coulter, Robert J., M.B., Ivor House, Gold Tops, Newport, Mon.

1895 †Courtenay, J. D., M.D., Ottawa, Canada.

ELECTED

1909 Craig, James A., M.B. H, University Square, Belfast. (C. 1915–17.)

1901 Crawley, F. C., M.D., 5, Fitzwilliam Place, Dublin.

1907 Cree, Robert Ewart, M.D., 40, Jesmond Road, Newcastle-on-Tyne.

1899 Cresswell, F. P. S., M.B., B.S., 24, Windsor Place, Cardiff.

1904 Cridland, A. Bernard, Salisbury House, Chapel Ash, Wolverhampton. (C. 1918–21.)

O.M. Critchett, Sir G. Anderson, Bart., K.C.V.O., 21, Harley Street, W. 1. (*Pres.* 1899-1901. C. 1883-6. V.-P. 1894-7, 1902-5.)

1898 Critchley, Harry G., M.D., 83, Park Lane, Croydon.

1906 Crocket, A. Pierce. (Address uncommunicated.)

1881 Cross, F. R., M.B., LL.D., Worcester House, Clifton, Bristol. (*Pres.* 1913–15. V.-P. 1898-1901, 1915-17. C. 1891-4.)

1902 Cruise, R. R., C.V.O. (C. 1917-20), 34, Wimpole Street, W. 1.

1912 Cummins, J. D., M.B., 10, Clare Street, Dublin.

1904 Cunningham, H. H., B., M.D., Lt.-Col. R.A.M.C., 15, Newport Road, Cardiff.

1905 Cunningham, J. F., O.B.E. (S.), 27, Weymouth Street, W. 1. (C. 1917-20).

1921 Cursetji, Capt. H. R., I.M.S., c/o 45, I.G.H., Cairo, E.E.F.

1916 Danis, Marcel, M.D., Rue de la loi 134, Brussels, Belgium.

1907 Davidson, Alex. Dyce, M.B., "Hollydene," Cholmeley Park, Highgate, N. 6.

1917 Davidson, Isaac A., M.D., 3, Laurington, Antrim Road, Belfast.

1903 Davies, David, M.B., 8, Lonsdale Gardens, Tunbridge Wells.

1908 Davies, D. L., M.S., M.D., 31, Newport Road, Cardiff.

1889 †Davis, G. C., 235, Macquarie Street, Sydney, New South Wales.

ELECTED

1914 De Lapersonne, Prof., M.D., 30 Rue de Lisbonne, Paris.

1903 Dean, C. W., Lindow Square, Lancaster.

1903 Dickson, R. H., Nelson Place, Newcastle-under-Lyme, Staffordshire.

1910 Dighton, Chas. A. Adair, M.B., 73, Rodney Street, Liverpool.

1881 Dixon, W. E., "Kirkee," Mill Road, West Worthing.

1905 Dorrell, E. Arthur, Bardsey, 19, Bath Road, Reading.

1920 Doyne, P. G., 8, Harley Street, W. 1.

1889 †Drake-Brockman, Herbert E., Col. I.M.S., c/o Thomas Cook and Son, Ludgate Circus, E.C. 4.

1895 Du Boulay, H. H., 2, Royal Terrace, Weymouth.

1909 Duggan, J. N., Sir J. C. Ophthalmic Hospital, Girguina, Bombay.

1886 Dunn, Percy, 54, Wimpole Street, W. 1.

1900 Eason, H. L., C.B., C.M.G., M.B., 62, Portland Place, W. 1. (C. 1915–17.)

1919 East, A. Gerard, M.B., Southleigh, Truro.

O.M.*Edmunds, Walter, M.B., 2, Devonshire Place, Portland Place, W. 1. (C. 1885-8.)

1902 †Elliot, Robert Henry, Lt.-Col. I.M.S. (retired), M.D., Sc.D., 54, Welbeck Street, W. 1.

1903 Ellis, W. F., c/o Messrs. Holt, 3, Whitehall Place, S.W. 1.

1921 Eminson, C. F., Gonerby House, Scotter, Gainsborough.

1908 Emmerson, Herbert H., 275, Glossop Road, Sheffield.

1883 *Emrys-Jones, A., M.D., 10, St. John Street, Manchester.

1918 Evans, Frederick Hudson, The Glen, 161, Lewisham Road, S.E. 13.

1900 Evans, J. Jameson, M.D., 41, Newhall Street, Birmingham.

1907 Fenton, Lt.-Col. A., M.B., I.M.S., c/o Messrs Thos. Cook and Son, Rangoon.

1911 Fenwick, George, Northern Club, Auckland, New Zealand.

ELECTED

1888 Fergus, A. Freeland, M.B., 14, Newton Place, Charing Cross, Glasgow. (C. 1905-8.)

O.M. †Ferguson, H. L., M.D., Dunedin, New Zealand.

1894 †Fischer, E. C., M.D., Cairo, Egypt.

1904 Fisher, Lt.-Col. J., D.S.O., I.M.S., c/o Messrs. Grindlay and Co., 54, Parliament Street, S.W. 1.

1895 Fisher, J. Herbert, M.B. (*Pres.*), 83, Wimpole Street, W. 1. (C. 1904-7; 1911-12; V.-P. 1918-20; S. 1907-10.)

1919 Fison, James, M.D., 9, North Park Road, Harrogate.

1912 Flaxman, Samuel C. R., Peckham House, Peckham, S.E. 15.

1917 Fleming, Norman B. R., M.B., 9, Harley Street, W. 1.

1889 Flemming, Percy, M.D., 70, Harley Street, W.1. (V.-P. 1911–13; C. 1901-4.)

1892 Folker, Herbert Henry, O.B.E., Bedford House, Shelton, Stoke-on-Trent.

1919 Ford, Rosa, M.B., 46, Bernard Street, Russell Square, W.C. 1.

O.M. Frost, W. Adams, Shepherd's Well, Forest Row, Sussex. (L. 1900-6. V.-P. 1906-9.)

1895 Galloway, A. Rudolf, O.B.E., M.B., 250, Union Street, Aberdeen.

1887 †Gardner, John J., M.D., 128, Bishop Street, Montreal, Canada.

1920 Gardner, Mark C., M.D., Box 252, G.P.O., Melbourne, Australia.

1913 Ghaswala, K. S., The Eye Hospital, Sleaton Road, Grant Road, Bombay, No. 7, India.

1912 Gibb, H. P., M.B., 91, Harley Street, W. 1.

1889 Gibbs, Alfred N. G., 52, Whiteladies Road, Clifton.

1902 †Gibson, J. Lockhart, M.D., Wickham Terrace, Brisbane, Australia.

1921 Gilmour, H. M., 22, Museum Street, Ipswich.

1918 Girgis, A. M., Assiut, Egypt.

1918 Girgis, B., Ophthalmic Hospital, Cairo.

ELECTED

1917 Giri, D. V., c/o Coutts & Co., 440, Strand, W.C. 2.

1899 Goldsmith, G. Harvey, M.B., Bedford.

1907 Goulden, Charles Bernard, O.B.E., M.D. (C.), 42, Welbeck Street, W. 1.

1904 Gowans, Thos., M.B., Henley Grange, Great Smeeton, near Northallerton.

1897 Granger, F. M., 18, Nicholas Street, Chester.

1895 †Grant, H. Y., M.D., 414, Delaware Avenue, Buffalo, U.S.A.

1895 †Gray, James, M.D., 119, Robert Street, Toronto, Canada.

1887 Green, Edwin Collier, 27, Friar Gate, Derby. (C. 1903-4.)

1903 Greene, Arthur, M.D., 4, Theatre Street, Norwich.

1911 Greeves, Reginald A., M.B., 23, Wimpole Street, W. 1.

1885 *Griffith, A. Hill, M.D., Minbridge House, near Woking, Surrey. (V.-P. 1905-8. C. 1893-6.)

1910 Griffith, Arthur Donald, M.B., 39, Hertford Street, Mayfair, W. 1.

1894 Grimsdale, Harold, M.B. (V.-P.), 3, Harley Place, Marylebone Road, N.W. 1. (C. 1907-10.)

1899 Gruber, Rudolph, M.D., 81, Harley Street, W. 1.

1908 Gunning, C. J. H., 50, Brook Street, Grosvenor Square, W. 1.

1910 Haab, Prof. O., 41, Pelikanstrasse, Zurich, Switzerland.

1889 Hailes, C. D. G., M.D., 2, Richmond Park Road, Clifton, Bristol.

1885 †Haines, Humphrey, Auckland, New Zealand.

1902 †Halliday, J. C., M.B., Macquarie Street, Sydney, N.S.W.

1900 Hallidie, Andrew, M.B., 7, Devonshire Place, Eastbourne.

1912 Hanafin, Major P. J., D.S.O., R.A.M.C. (Address uncommunicated.)

1901 Hancock, Edw. D., Merrow Grange, Guildford

1908 Hanna, Henry, M.B., 30, University Square, Belfast.

ELECTED

1901 Hanson, Reginald E., M.B., 20, Kensington Park Gardens, W. 11.

1920 Harford, C. F., M.D., 30, Finsbury Square, E.C. 2.

1900 Harman, N. B., M.B., 108, Harley Street, W. 1.

1902 Harries-Jones, E., M.D., 16, Castilian Street, Northampton.

1910 Harston, George M., M.D., Hong Kong.

1882 *Hartridge, Gustavus, 12, Wimpole Street, W. 1. (C. 1889-92, 1895-8. S. 1892-5. V.-P. 1910-11.)

1905 †Harty, G. W., M.B., Ch.B., Wellington, New Zealand.

1899 Hawkes, C. S., Bethnal Green Military Hospital, London, E.

1901 Hawthorne, C. O., M.D., 63, Harley Street, W. 1.

1908 Hay, Percival J., M.D., 350, Glossop Road, Sheffield.

1892 Haydon, Frank, Apothecaries' Hall, Water Lane, Blackfriars, E.C. 4.

1899 Henderson, Edward E., M.B., Redrigg, Ferry Road, Felixstowe.

1903 Henderson, Thomson, M.D., 15, The Ropewalk, Nottingham.

1896 Henry, R. Wallace, M.D., 6, Market Street, Leicester.

1905 Hepburn, Malcolm Langton, M.D., 111, Harley Street, W. 1.

1897 Herbert, Lt.-Col. Herbert, I.M.S. (retired), 19, Brunswick Place, Hove, Sussex. (C. 1911–13.)

1887 *Hern, John, M.D., Semmercote, Darlington.

1910 Heron, David, Burton Court, Chelsea, S.W. 3.

1905 Hewkley, F., 72, Wickham Road, Brockley, S.E. 4.

1900 Heyliger, E. D. Scott, M.B., C.M., 89, Preston New Road, Blackburn.

1895 Hickman, H. R. Belcher, M.B., Castle House, Flax Bourton, near Bristol.

1920 Highet, H. C., M.D., Radley House, Winchester.

1916 Hine, Montague, M.D., 30, Weymouth Street, W. 1.

1888 *Hinnell, J. S., M.D., 62, Garland Street, Bury St. Edmunds.

ELECTED

1905 Hird, R B., M.D., 52, Newhall Street, Birmingham.

1919 Hodge, G., M.D., 603, Dorchester Street West, Montreal.

1897 Hogg, G. H., M.D., 37, Brisbane Street, Launceston, Tasmania.

1911 Holmes, Gordon M., C.M.G., C.B.E., M.D., 101, Harley Street, W. 1. (S. 1912–15, C. 1915–17.)

1889 Holthouse, Edwin H., M.B., 35, Nottingham Place, W. 1.

1917 Holyoak, W. L., M.D., 45, Welbeck Street, W. 1.

1905 Hosford, J. S., 31, Weymouth Street, W. 1.

1893 †Howe, Lucien, 520, Delaware Avenue, Buffalo, N.Y., U.S.A.

1908 Hudson, A. C., M.D., 50, Queen Anne Street, W. 1.

1889 †Hughes, Samuel H., 173, Macquarie Street, Sydney, New South Wales.

1893 †Hughes, Wilfrid Kent, M.B., 102, Collins Street, Melbourne.

1908 Hunter, George, 31, Bridge Street, Inverness.

1919 Husain, T., Khan-Bahadur Eye Hospital, Allahabad, India.

1901 Inman, Wm., M.B., 22, Clarendon Road, Southsea.

1898 James, George Brooksbank, 5, Harley Street, W. 1. (C. 1911–13.)

1908 James, Robert Rutson (C.), 46, Wimpole Street, W. 1. (S. 1918–21.)

1905 Jaques, R., 20, Athenæum Street, Plymouth.

1918 Jellett, James William Henry, M.D., Dublin, 11, Beresford Street, Waterford.

1883 †Jenkins, E. J., M.D., Nepean Towers, Douglass Park, Sydney, N.S.W., Australia.

1908 Jeremy, H. Rowe, 62, Queen Anne Street, W. 1.

1910 Jewell, William H., M.D., 27, Queen Anne Street, W. 1.

1882 Johnson, G. Lindsay, M.D., Britannia Buildings, West Street, Durban, Natal.

1888 †Johnston, Geo. D., Georgia Street, Vancouver, British Columbia.

ELECTED

1919 Joll, Miss Mary E., M.D., 25, Gordon Square, W.C. 1.

1898 *Jones, George, M.B., 8, Church Terrace, Lee, S.E. 13.

1897 Jones, Hugh E., 19, Rodney Street, Liverpool.

1894 †Jones, R. H., M.B., B.S., 209, Macquarie Street, Sydney, New South Wales.

1914 Joseph, Hugh Percival, Eye Hospital, Colombo, Ceylon.

1905 Juler, F. A., M.B. (S.), 14, Portland Place, W. 1.

1914 Karani, N. N., "Eye Clinic," near Edward Theatre, 18, Kalbadevi Road, Bombay.

1921 Kealy, James J., M.B., Lucania Buildings, Llanelly, S. Wales.

1899 Keeling, G. S., M.D., Attleborough, Norfolk.

1900 †Kelsall, H. T., M.D., 1, Devonshire Terrace, Perth, W. Australia.

1898 †Kendall, H. W. Martindale, Wellington, New Zealand.

1888 †Kenny, Augustus Leo, M.B., 87, Collins Street, Melbourne, Victoria, Australia.

1921 Kiep, Walter H., M.B., Kaser-el-Ami Hospital, Cairo, Egypt.

1913 Killen, W. M., M.D., 32, College Gardens, Belfast.

1904 Killick, Chas., M.D., 14, Spring Bank, Manningham Lane, Bradford.

1906 Kilkelly, Col. P. P., I.M.S. (retired), c/o Messrs. H. S. King and Co., Pall Mall, S.W. 1.

1895 Knaggs, Robert Lawford, M.D., 27, Park Square, Leeds.

1910 Knapp, Arnold, M.D., 10, East 54th Street, New York, U.S.A.

1911 Lang, B. T., B.C., 22, Cavendish Square, W. 1.

O.M. Lang, William, 22, Cavendish Square, W. 1. (C. 1886-9. V.-P. 1900-3 (*Acting Pres.* 1903.)

O.M. Lawford, J. B., M.D., LL.D., 27, Weymouth Street, W. 1. (C. 1886-9; 1898-1901. S. 1895-8. V.-P. 1905; 1913-16. T. 1905-11. *Pres.* 1911-13.)

ELECTED

1889. *Laws, Wm. G., M.B., 3, East Circus Street, Nottingham. (C. 1909-11.)

1896 Lawson, Sir Arnold, K.B.E. (T.), 12, Harley Street, W. 1. (V.-P. 1917. C. 1909-1911.)

1895 †Lea, J. Augustus, M.B., Grahamstown, Cape Province, S. Africa.

1885† Le Cronier, Hardwick, St. Heliers, Jersey.

1917 Leask, H. L. G., M.D., 70, Dixon Avenue, Crosshill, Glasgow.

O.M. Lediard, H. A., M.D., 26, Lowther Street, Carlisle. (C. 1900-1.)

1912 Lee, H., M.B., 6, Park Square, Leeds.

1904. †Lee, W. A., Col. I.M.S. (retired), 44, Primrose Hill Road, N.W. 3.

1911 Letchworth, T. W., M.B., 68, Claremont Road, Surbiton.

1903 Levy, A., M.D., 67, Wimpole Street, W. 1.

1907 Lindsay, W. J., M.D., 84, Herne Hill, S.E. 24.

1921 Lister, Major A. E. J., I.M.S., c/o Lloyds Bank, Dursley, Gloucestershire.

1896 Lister, Sir W. T., K.C.M.G., M.B., 24, Devonshire Place, W. 1. (V.-P. 1918–21. C. 1907-10.)

1892 Lodge, Samuel, jun., M.D., 28, Manor Road, Bradford.

1911 Loosely, Alfred E. A., M.B., 25, New Cavendish Street, W. 1.

1903 †Lückhoff, James, M.D., Rhodes Buildings, St. George's Street, Capetown.

1899 Lyle, H. Willoughby, M.D., Speldhurst, Elmfield Road, Bromley, Kent.

1900 MacCallan, Arthur Ferguson, C.B.E., M.B., Public Health Department, Cairo, Egypt.

1913 McCready, W., M.B., 2, University Square, Belfast.

1918 McCulloch, R. J. P., M.B., L.R.C.P., 102, College Street, Toronto, Canada.

1920 MacDonald, Alexander, M.B., c/o J. McWhirter, Esq., The Valley, Brisbane, Queensland.

1905 Macdonald, J. G., Imperial Chambers, Dee Street, Invercargill, New Zealand.

ELECTED

1919 MacFetridge, William C., M.D., 27, Upper Fitzwilliam Street, Dublin.

1920 MacGillivray, Allister M., M.B., 23, South Tay Street, Dundee.

1890 *MacGillivray, Angus, M.D., 23, South Tay Street, Dundee. (C. 1902-5.)

1902 Mackay, D. Matheson, M.D., 15, Albion Street, Hull.

1888 *Mackay, George, M.D., 26, Drumsheugh Gardens, Edinburgh. (C. 1900-2. V.-P. 1906-9.)

1889 †Mackenzie, F. Wallace, M.B., 139, Upper Willis Street, Wellington, New Zealand

1895 McKenzie, H. V., M.D., Elmbank, Abbey Road, Torquay.

1889 MacLehose, Norman M., M.B., 18, Harley Street, W. 1. (C. 1902-5.)

1897 †MacLennan, Duncan N., M.D., 126, Bloor Street West, Toronto.

1892 †MacLeod, Charles G., M.D., 157, Macquarie Street, Sydney, N.S.W.

1902 McMullen, W. H., M.B., O.B.E., 133, Harley Street, W. 1. (C. 1914-17.)

1911 McNabb, Henry H., M.D., 8A, St. John Street, Manchester.

1918 MacNeil, Capt. Frank A., 810, Boyd Buildings, Winnipeg, Canada.

1912 McPherson, Major, I.M.S., c/o Ophthalmic Hospital, Bombay, India.

1911 MacQueen, J. F. (Address uncommunicated.)

1899 Maddox, Ernest E., M.D., Glenartney, Poole Hill, Bournemouth. (C. 1904-6.)

1918 Maghy, Charles Alfred, Suite 409, Timken Building, San Diego, California, U.S.A.

1899 †Manché, Charles, B.A., M.D., 33, Strada Alessandro, Valletta, Malta.

1901 †Manning, Leslie S., M.B., Christchurch, New Zealand.

1911 Manson, W. H., M.D., 17, Royal Terrace, Glasgow, W.

ELECTED

1904 Markus, Charles, M.D., 28, Wimpole Street, W. 1.

1883 †Marlow, Frank William, M.D., 200, Highland Street, Syracuse, N.Y., U.S.A.

1916 Marquez, M., Dr., Puerta del Sol, 13, Madrid, Spain.

1907 Marshall, James Cole, M.D., 126, Harley Street, W. 1.

1888 †Martin, Albert, M.D., Wellington, New Zealand.

1905 Massey, A. Yale, M.D., 24, Tavistock Square, W.C. 1.

1918 Mathieu, Capt. Albert, C.A.M.C. (Address uncommunicated).

1918 Matthews, Richard H., M.D., 4, Upper Fitzwilliam Street, Dublin.

1916 Maxted, George, M.D., 14, Thorpe Mansions, Norwich.

1914 Maxwell, Miss E. M., M.B., 19, Lower Baggot Street, Dublin.

1904 May, H. J., M.B., B.C., 21, The Avenue, Southampton.

1902 Mayou, Stephen (C.), 59, Harley Street, W. 1. (C. 1912–15. S. 1916–19.)

1912 Mead, John Clarke, M.B., "Bryn-y-mor," Yarmouth Road, Lowestoft.

1901 Menzies, J. A., M.B., 9, Castle Hill Avenue, Folkestone.

1920 Miller, H. P., M.D., 100, Stoke Newington Road, N. 16.

1897 †Minnes, Robert Stanley, M.D., 127, Metcalfe Street, Ottawa, Ontario.

1911 Mitchell, Leonard J. C., 4, Collins Street, Melbourne.

1921 Moodie, A. R., M.B., 5, Windsor Terrace, Dundee.

1896 Mooney, Herbert C., M.B., 33, Fitzwilliam Place, Dublin.

1908 Moore, R. Foster, O.B.E., M.B., 91, Harley Street, W. 1.

1909 Morrell, Reginald A., Headington Orthopaedic Hospital, Headington, Oxford.

O.M. Morton, A. Stanford, M.B., 64, Pembroke Road, Clifton, Bristol. (C. 1886-9. V.-P. 1902-5.)

1896 Mott, Sir F. W., K.B.E., M.D., F.R.S., 25, Nottingham Place, W. 1. (V.-P. 1904–7.)

ELECTED

1908 Moxon, Frank, O.B.E., M.B., B.S., 4, Bentinck Street, W.1.

1921 Mukerjee, S., 13, Kyd Street, Calcutta.

1916 Mulholland, P. J. H., 5, University Terrace, Belfast.

1909 Naylor, W. Roebuck, 14, Carr Road, Nelson, Lancs.

1920 Neame, Humphrey, 256, Temple Chambers, Temple Avenue, E.C. 4.

1909 Nell, Andreas, Victoria Eye and Ear Hospital, Colombo, Ceylon.

1881 Nicholson, A., M.B., 30, Brunswick Square, Brighton.

1910 Nordenson, Dr. Erik, 10, Wasagatan, Stockholm, Sweden.

1912 Norman, Alfred Clarence, M.D., X-ray Institute, New General Hospital, Baghdad, Mesopotamia. *Trans.* to The Glen, Stonehouse, Glos.

1889 †O'Kinealy, Frederick, C.I.E., Lt.-Col., I.M.S., c/o Messrs. King, Hamilton and Co., 7, Hare Street, Calcutta.

1911 Oliver, M. W. B., O.B.E., M.B., 128, Harley Street, W. 1.

1914 Oliver George H., 284, Manningham Lane, Bradford.

1899 Ormond, Arthur Wm., C.B.E., 7, Devonshire Place, W. 1. (C. 1910-12).

1892 †Orr, Andrew William, M.D., Brisbane.

1890 †Osborne, A. B., M.D., 46, McNab Street South, Hamilton, Canada.

1890 †Palmer, L. Loran, M.D. (Address uncommunicated.)

1894 *Parker, Herbert, Saragossa House, New Street, Henley-on-Thames.

1899 Parker, Herbert George, 13, Chorley New Road, Bolton.

1900 Parsons, John Herbert, C.B.E., F.R.S., M.B., D.Sc., (V.-P.), 54, Queen Anne Street, W.1. (C. 1909-12.)

1887 †Patel, D. H., Bai Hirabai, B. J. Charitable Dispensary Tardeo, Bombay.

1907 Paterson, James V., M.B., 11, Melville Street, Edinburgh.

ELECTED

1900 †Patkar, Bhagvant Sakharam, Carnac Road, Kalkadeir Post, Bombay, India.

1902 Paton, Leslie, M.B., 29, Harley Street, W. 1. (C. 1912–15.)

1918 Pearse, Patrick, L.R.C.P., L.R.C.S., 17, The Crescent, Limerick.

1888 Percival, Archibald Stanley, M.B., B.Ch., Westward, Tankerville Terrace, Newcastle-on-Tyne. (C. 1906-9.)

1891 Perry, Sir A., M.D., Surgeon-Major, Principal Civil Medical Officer, Colombo, Ceylon.

1889 †Perry, Francis F. (Address uncommunicated.)

1920 Pesikaka, B. H., Shakspear Hut, Gower Street, W.C. 1.

1895 Pickard, Ransom, M.D., 31, East Southernhay, Exeter.

1916 Pike, N., M.D., 10, York Terrace, St. George's Road, Cheltenham.

1910 Pisani, Lt.-Col. L. J., I.M.S. (retired), 49, Wimpole Street, W. 1.

1900 †Pockley, Francis Antill, M.D., 227, Macquarie Street, Sydney, N.S.W.

1903 Pollock, W. B. Inglis, M.D., 21, Woodside Place, Charing Cross, Glasgow.

1896 *Pooley, G. H., 304, Glossop Road, Sheffield.

1894 †Pope, R. J., M.D., Box 497, G.P.O., Sydney, N.S.W.

1902 Potter, Bernard E., M.B., 26, Park Crescent, Regent's Park, W. 1.

1903 *Potts, George, Bower Cottage, Tonbridge Road, Maidstone.

1899 Price, Henry J., Maldon, Essex.

1882 Prichard, A. W., 6, Rodney Place, Clifton

1908 Pridmore, Walter G., Major I.M.S., c/o Grindlay and Co., 54, Parliament Street, S.W. 1.

1903 Pritchard, Eric L., M.D., 70, Fairhazel Gardens, N.W.

1892 Pronger, Charles Ernest, Litchdon, Harrogate.

ELECTED

1909 Prowse, S. Willis, M.D., 706, Union Bank Buildings, Winnipeg, Canada.

1911 Quick, Hamilton E., M.B., "Varfell," 130, Eaton Crescent, Swansea.

1889 Ramsay, A. Maitland, M.D., 15, Woodside Place, Glasgow. (C. 1909-11. V.-P. 1915–16.)

1899 Read, E. I., Government Medical Officer, 41, Frederick Street, Port of Spain, Trinidad, West Indies.

1881 †Reeve, R. A., M.D., 22, Shuter Street, Toronto, Canada. (V.-P. 1907-10.)

1921 Renwick, Gordon, Royal Eye Hospital, Oxford Road, Manchester.

1891 Reynolds, Austin Edward, 35, Finsbury Square, E.C. 2.

1913 Riad, M., Kasr el Aino Hospital, Cairo, Egypt.

1897 Richmond, R., M.D., 29, Lingfield Road, Wimbledon, S.W. 19.

1892 Ridley, Nicholas C., M.B., 27, Horse Fair Street, Leicester.

1914 Roberts, Miss Adeline Mary, M.D., 4, Nottingham Place, W. 1.

1921 Roberts, B. H. StClair, Cwm House, Castle Street, Worcester.

1885 *Roberts, Edward, Penywern, Aberystwith, Cardiganshire.

1896 †Roberts, Col. Sir James R., C.I.E., M.B., I.M.S., c/o Messrs. King, King and Co., Bombay.

1891 Robertson-Fullarton, Archibald Louis, M.B., C.M. (Address uncommunicated).

1921 Robinson, F. H., M.B., 22, Adderley House, Johannesburg, South Africa.

O.M. Rockliffe, W. C., M.D., Selioke, Hessle, Yorks. (C. 1892-5. V.-P. 1900–3.)

1898 Roe, Arthur Legge, 43, Pryme Street, Hull.

1898 Roll, G. W., M.B., B.C., 7, Upper Wimpole Street, W. 1. (C. 1910-12.)

1890 Rolston, John R., 14, The Crescent, Plymouth.

ELECTED

1891 Roper, Arthur Charles, The Shrubbery, Exeter.

1919 Rose-Innes, Arthur, 25, Ashchurch Park Villas, W. 12.

1921 Ross, James Alexander, M.B., Cavendish House, Carlisle.

1882 †Roth, Reuter E., D.S.O., 42, College Street, Hyde Park, Sydney, New South Wales.

1893 *Rowan, John, M.B., 10, Woodside Crescent, Charing Cross, Glasgow.

1899 *Roxburgh, A. B., M.B., 3, Manchester Square, W. 1.

1895 Russell, J. S. Risien, M.D., 44, Wimpole Street, W. 1. (C. 1900–3. S. 1903-6. C. 1906-9.)

1903 Rutherford, A. Freer, M.B., 19, Abbey Road, Barrow-in-Furness.

1900 †Sager, D. S., M.D., Brantford, Ontario, Canada.

1884 *Sandford, Arthur W., M.D., 13, St. Patrick's Place, Cork. (C. 1896-9. V.-P. 1902-5.)

1918 Santos, Costa, Lisbon, Portugal.

1918 Saunders, P. W., M.B., 63, Wimpole Street, W. 1.

1907 Scott, G. Affleck, M.B., Kingsland House, Ballarat, Victoria.

1918 El Seesy, A. M., Cairo, Ophthalmic Hospital.

1892 Shannon, John Rowlands, M.D., 17, East 38th Street, New York City, U.S.A.

O.M. Sharkey, Sir S. J., M.D., 24a, Portland Place, W. 1. (S. 1885-8. C. 1888-91. V.-P. 1900-2.)

1918 Shaw, David le Baron. (Address uncommunicated.)

1920 Sichel, Alan W., M.B., S.A. Association Chambers, 6, Church Square, Cape Town.

1920 Simpson, William Henry, M.B., Royal London Ophthalmic Hospital, City Road, E.C. 1.

1899 Sinclair, A. H. H., M.B., 3, Charlotte Square, Edinburgh. (C. 1917–1919.)

1891 Sinclair, Walter William, M.B., 3, Arcade Street, Ipswich. (C. 1909-1912.)

ELECTED

1912 Smith, D. Priestley, M.B., 95, Cornwall Street, Birmingham.

1889 Smith, John, M.D., Brycehall, Kirkcaldy.

O.M. Smith, Priestley, M.B., M.Sc., 52, Frederick Road, Edgbaston, Birmingham. (V.-P. 1887-90; 1898-1901; 1907-10. C. 1883-6. *Pres.* 1905-7.)

1903 Smyth, Ernest J., M.B., Sevington, Epsom Road, Guildford.

1911 Snell, H. Cecil, 70, Hanover Street, Glossop Road, Sheffield.

1910 Snellen, Prof. H. Biltstraat, Utrecht, Holland.

1901 Snowball, Thomas, M.B., 83, Bank Parade, Burnley.

1919 Sobhy, N., M.D., c/o Ophthalmic Hospitals, Public Health Department, Cairo.

1919 Souter, Wm. Clarke, M.D., 2, Bon Accord Square, Aberdeen.

1889 Spencer, Matthew H., M.D., 92, Oxford Gardens, North Kensington, W. 10.

1889 Spicer, Wm. T. Holmes, M.B., 5, Manchester Square, W. (C. 1900-2. L. 1907-12. V.-P. 1910-12.)

1905 Sprawson, F. C., M.B., 7, Imperial Terrace, Claremont Park, Blackpool.

1916 Stack, E. H., M.B., B.C., Arvalee, Clifton Down Road, Bristol.

1895 †Stamberg, A. C., M.B., 5, Windsor Crescent, St. Heliers, Jersey, Channel Islands.

1886 Stephenson, Sydney, M.B., 33, Welbeck Street, W. 1. (C. 1898-1901, 1904-7. S. 1901-4. V.-P. 1915–17.)

1896 Stevenson, Edgar, M.D., 39, Rodney Street, Liverpool.

1904 Stevenson, John Simpson, M.B., Royal Exchange Buildings, Cathedral Square, Christchurch, New Zealand.

1920 Stevenson, Thomas, M.D., 40, Rodney Street, Liverpool.

ELECTED

1905 Steward, E. S., 10, Princes' Square, Harrogate.

1913 Stewart, John Barbour, M.B., 17, Woodside Terrace, Glasgow.

1893 Stirling, Alexander Williamson, M.D., Empire Buildings, Atalanta, Georgia.

1887 †Stirling, J. W., M.B., 388, Sherbrook Street West, Montreal, Canada.

O.M. Story, J. B., M.B. (V.-P.), 6, Merrion Square North, Dublin. (C. 1885-8. V.-P. 1894-7. *Pres.* 1918-20.)

1904 Sykes, Walter, 31, Winckley Square, Preston.

1888 *Sym, William George, M.D., 12, Alva Street, Edinburgh. (V.-P. 1918–21. C. 1906-9.)

1883 †Symons, Mark Johnston, M.D., North Terrace, Adelaide, South Australia.

1907 Tampi, K. R., Trivandrum, South India.

O.M. Tay, Waren, 61, Oakfield Road, West Croydon. (C. 1880-2.)

1903 Taylor, H. H., 36, Brunswick Square, Hove, Brighton.

1899 Taylor, Inglis, M.B., 22a, Cavendish Square, W. 1.

1891 Taylor, James, C.B.E., M.D., 49, Welbeck Street, W. 1. (V.-P. 1910-11. C. 1894-7, 1900–3. S. 1897-1900. T. 1911-1918.)

1889 Taylor, S. J., M.B., 44, Prince of Wales' Road, Norwich. (C. 1904-7.)

1919 Tewfic, M., c/o Ophthalmic Hospitals, Department of Public Health, Cairo.

1900 Thomas, Frank G., M.B., 22, Walter Road, Swansea.

1895 Thompson, A. Hugh, M.D., 36, Weymouth Street, W. 1. (C. 1910-12.)

1895 Thompson, George W., M.B., 80, Harley Street, W. 1.

1895 *Thompson, Robert, M.D., B.S., Bunya Bunya, Wickham Terrace, Brisbane, Queensland.

1911 Thomson, Eric A., M.B., Maison Anton Raad, Beyrout, Syria.

1905 Thomson, H. Wright, D.S.O., M.D., 3, Sandyford Place, Glasgow.

ELECTED

1898 Thomson, W. Ernest, M.D., Viewbank, Bothwell, Lanarkshire.

1919 Thorpe, Reginald, 15, Cavendish Place, W. 1.

1919 Tivy, Cecil B. F., M.B., The Retreat, Higher Hooe, Plymstock, South Devon.

1883 †Tobin, William, c/o Messrs. John Tobin and Co., Halifax, Nova Scotia, Canada.

1900 Tomlinson, John H., Tudor Lodge, Egham, Surrey.

1904 †Tooke, Frederick T., M.D., 36, Mountain Street, Montreal, Canada.

1895 Toombs, Herbert George, 193, Cromwell Mansions, Cromwell Road, S.W. 7.

1904 Townsend, T. H. D., M.B., 14, St. Patrick's Hill, Cork.

1912 Traquair, H. Moss, M.D. (C.), 16, Manor Place, Edinburgh.

1905 Trench, F. P., M.B., 81, Eaton Terrace, S.W. 1.

1902 †Trilokekar, V. S., 308, Lohar Street, Bombay, India.

1917 Tuckett, Ivor Lloyd, M.D., 2, Trebovir Road, Earls Court, S.W. 5.

O.M. Tweedy, Sir John, LL.D., 100, Harley Street, W. 1. (*Pres.* 1903-5. C. 1884-7. V.-P. 1891-4, 1905-8.)

1898 Tyrrell, F. Astley-Cooper, M.B., 27, Queen Anne Street, W. 1.

1883 Uhthoff, J. C., M.D., Wavertree House, Furze Hill, Brighton. (C. 1905-8. V.-P. 1908-12.)

1894 Usher, C. H., M.B., 3, Bon Accord Square, Aberdeen. (C. 1909-1912.)

1916 Valentine, John A., M.D., 53, Kent Road, Southsea.

1920 Veitch, A. H., M.B., Birmingham and Midland Eye Hospital, Birmingham.

1913 Viner, Geoffrey, M.D., 27, Queen Anne Street, W. 1.

1888 Walker, Cyril H., M.B. (V.-P.), 8, Oakfield Road, Clifton, Bristol. (C. 1907-10).

ELECTED

1916 Wallace, William, M.D., 11, Ladbroke Road, W. 11.

1916 Wallis, G. F. C., M.D., 1, Price's Avenue, Cliftonville, Margate.

1900 Wardale, John D., M.B., Carlton Villa West, Jesmond Road, Newcastle-on-Tyne.

1914 Weeks, John Elmer, M.D., D.Sc., 46, East 57th Street, New York City, U.S.A.

1910 †Weihen, A. Wallace, M.D., 183, Macquarie Street, Sydney, N.S.W.

1887 Wells, Arthur P. L., M.B., 48, Belsize Square, Hampstead, N.W. 3. (C. 1896-9.)

1885 Werner, Louis, M.B., 31, Merrion Square North, Dublin. (C. 1902-5.)

1908 Wharton, John, M.D., 21, St. John Street, Manchester.

O.M. *Wherry, G. E., M.B., Corpus Buildings, Cambridge (C. 1897-1900.)

1920 White, Harry V., M.C., M.D., 7, Oak Road, Withington, Manchester.

1895 Whitehead, Arthur Longley, M.B., 31, Park Square, Leeds. (C. 1912–15.)

1920 Whiting, Maurice H., O.B.E., M.B., 9, Welbeck Street, W. 1.

1918 Whittington, Capt. T. H., Oakfield, Carshalton Road, Sutton, Surrey.

O.M. Williams, R., 125, High Street, Bangor, North Wales. (V.-P. 1896-9.)

188 †Willis, C. Fancourt, C.B., M.D., Col., I.M.S. (retired), Frith Manor, East Grinstead.

1920 Wilson, David, M.B., 30, New North Road, Huddersfield.

1920 Wilson, Edwd. Fras., M.B., Glenalt, Omagh, Co. Tyrone, Ireland.

1914 Wilson, James Alexander, M.D., 4, Central Avenue, Cambuslang, Glasgow.

1911 Wilson, S. A. Kinnier, M.D., 14, Harley Street, W. 1. (C. 1918–21. S. 1915-18.)

ELECTED.

1921 Wong, Sik To, "Lok-lo-ha," North Road, Hythe, Kent.

1900 Wood, C. G. Russ, 12, St. John's Hill, Shrewsbury.

1889 Wood, David J., M.B., National Mutual Building, Church Square, Cape Town, South Africa.

1903 Wood, Percival, The Grange, Crawley.

1909 Wood, R. Moorsom, 32, Beaumont Street, W. 1.

O.M.* Woodhead, Sir G. Sims, K.B.E., M.D., LL.D., Dysart House, Luard Road, Cambridge. (C. 1894-5. V.-P. 1905-8.)

1899 *Worth, Claud, 36, Harley Street, W. 1.

1910 Worton, A. S., M.D., 7, Manchester Square, W. 1.

1890 *Wray, Chas., Bank Chambers, North End, Croydon.

1898 †Wright, Edward Wm., M.D., 115, Montague Street, Brooklyn, New York.

1908 Wright, F. R. Elliston, M.B., Braunton, North Devon.

1896 Yarr, Col. Sir Michael T., K.C.M.G., C.B., A.M.S., Army and Navy Club, Pall Mall, S.W. 1.

1910 Yearsley, J. Herbert, "Giffnock," 6, Christchurch Road, Bournemouth.

1917 Young, George, M.D., Cambridge Road, Colchester.

1912 Zorab, Arthur, M.B., Winchester House, Hulse Road, Southampton.

RULES.

1. Object of the Society.—The object of the Society is the cultivation and promotion of Ophthalmology.

2. Meetings.—The Society shall hold a meeting each year; the sittings shall be held on two or more consecutive days. On each day there shall be usually two sittings. The date and place of meeting shall be chosen by the Council.

3. Constitution.—The Society shall consist of Ordinary and Honorary members. All medical practitioners whose qualifications are satisfactory to the Council of the Society shall be eligible as Ordinary members. Other Ophthalmological Societies in the British Empire, approved by the Council, may become affiliated.

4. Officers of the Society.—The officers of the Society shall consist of a President, four Vice-Presidents, a Treasurer, two Secretaries and six other members, who together with the President of each affiliated Society or representative accredited by him, shall form the Council and manage the Society's affairs.

5. Election of Members.—Every applicant for admission to the Society shall send to one of the Secretaries a form signed by at least three members, who have personal knowledge of the applicant, or by the President and Secretary of an affiliated Society. Such application shall be submitted to the Council, and if approved the applicant shall forthwith be admitted a member.

6. Honorary Members.—The Council shall have the power of electing as Honorary members men of distinguished eminence in Ophthalmology, or in the sciences bearing upon it.

7. Subscriptions.—The Annual Subscription shall be £1 11*s.* 6*d.* payable in the month of October. No member whose subscription is in arrear shall be entitled to attend the meeting. Any member whose subscription is twelve months in arrear shall cease to be a member of the Society.

8. Election of Officers. The Officers of the Society shall be elected yearly by Ballot at a Business sitting held during the meeting. A balloting list of the names recommended by the Council for election shall be posted to each member two weeks previously. At the Business sitting twelve shall form a quorum.

9. Duration of Office.—The President shall not hold office for a period of more than two consecutive years. No other member of Council, except the Treasurer, shall hold the same office for more than three consecutive years.

10. President and Vice-Presidents.—The President shall regulate all the proceedings of the Society and Council, state and put questions, interpret the application of the laws, and decide any doubtful points. He shall check irregularities and enforce the observance of the laws. He shall sign the minutes of General and Council meetings. In the absence of the President one of the Vice-Presidents, the Treasurer, or some other member chosen by the meeting, shall perform his duties.

11. Secretaries.—The Secretaries shall manage all correspondence, and shall keep the Minutes of the Society and Council. They shall notify to new members their election. They shall arrange with the President the order of proceedings at the meetings. They shall have charge of and shall keep a register of all papers communicated, and shall be the Editors of the 'Transactions.'

12. Treasurer.—The Treasurer shall receive all moneys due to the Society, and make all payments ordered by the Council, keeping an account of all such receipts and payments. The accounts shall be audited once a year and presented to the Society at the Annual Business Meeting. Two members of the Society shall be nominated by the President to audit the Treasurer's accounts.

13. Meetings of Council.—The Council shall meet as frequently as necessary during the Annual Meeting and at other times if specially convened. Five shall form a quorum. The President shall have a casting vote in addition to his ordinary vote. The Council shall decide upon all questions relating to the reception of communications, and shall have power to submit any paper to referees.

14. Vacancies of Offices.—The Council shall have the power of filling up any vacancies which may occur in any of the offices of the Society between one Annual Meeting and the next.

15. 'Transactions.'—The Society shall publish a yearly volume of 'Transactions' as soon as possible after the Annual Meeting (*vide* Bye Law 1 concerning communications). There shall be an Editorial Committee consisting of the President, the Secretaries and two other members of Council, together with the Secretaries of affiliated Societies. A copy of the 'Transactions' shall be sent to every member whose subscription has been duly paid; and to each Honorary member.

16. Publication of Papers and Discussion.—No paper shall be accepted if it has been published elsewhere. No paper shall be read before the Society unless a copy of it has been sent to the Secretaries at least four weeks before the meeting, together with an abstract suitable for immediate publication in the journals. When possible, notice should be given relating to card cases, and a short abstract of all papers to be read before the Society shall be distributed to all members before the meeting. No report of the meetings of the Society may be published by members or others without the sanction of the Council.

17. Notice of Meeting.—Three months before the date of the Annual Meeting a preliminary notice of the meeting shall be sent to every member.

18. Visitors.—Any member of the medical profession may attend a meeting of the Society (except the Annual Business Meeting) on being introduced by a member of the Society.

The Library has now been transferred to the premises of the Royal Society of Medicine, 1, Wimpole Street.

LIBRARY RULES.

1. The Library shall be open at the same hours as that of the Royal Society of Medicine, viz. from 11 a.m. to 6.30 p.m. daily, except Sundays.

2. Members will be entitled to read the books at 1, Wimpole Street, between these hours, or to take them out on signing a receipt provided for that purpose.

3. A large number of periodicals will be accessible to members in the Library. The current number may not be taken out of the Library.

4. A book must be returned at the expiration of a fortnight if wanted by any other member. The Librarian will in such a case write to the member in whose name the book was taken out.

5. If the book be not returned within four days of such notice a fine of 6d. will be charged for each day that the book is retained beyond such days of grace.

6. Instruments and drawings cannot be taken out of the Library except by special permission.

7. A member taking out a book will be held responsible for its being returned in good condition.

8. Members of the Ophthalmological Society who are also Members of the Section of Ophthalmology of the Royal Society of Medicine can have the full use of the Fellows' Library on payment of an additional guinea instead of the usual subscription of two guineas.

ADAMS FROST COLLECTION OF LANTERN SLIDES.

1. The slides shall be in the custody of the Librarian.

2. They may be lent, for the purpose of teaching, to teachers in any recognised Medical School on application to the Librarian.

3. The regulations under which the slides may be borrowed, together with a list of the slides, shall be printed (*a*) in the *Transactions;* (*b*) in the Catalogue of the Library; (*c*) on leaflets which may be sent to enquirers.

4. Other slides may be added to the collection, but the numbering (in so far as it coincides with that of the figures in Frost's *Fundus Oculi*) shall be retained.

5. The following are the regulations under which the slides may be borrowed:

Regulations for the Loan of Lantern Slides.

1. Not more than 20 slides may be borrowed at one time.

2. Not less than three days' notice of the wish to borrow slides shall be given, and a list giving the numbers of the slides required shall be sent to the Librarian.

3. The borrower shall sign a receipt for the slides, which will be given back to him on their return.

4. The slides must be returned within three days, no other slides can be lent to the same borrower till this has been done.

5. Any slides broken, lost, or damaged shall be replaced or repaired at the expense of the borrower.

THE BOWMAN LECTURE.

Resolution of Council, September 18th, 1883.

"That in recognition of Mr. Bowman's distinguished scientific position in ophthalmology and other branches of Medicine, and in commemoration of his valuable services to the Ophthalmological Society, of which he was the first President, the Council shall each year, or periodically, nominate some person to deliver a lecture before the Society, to be called 'The Bowman Lecture,' which shall consist of a critical *résumé* of recent advances in ophthalmology or in such subject or subjects as the Council shall select, or of any original investigation, and shall be delivered at a special meeting of the Society held for the purpose, at which no other business shall be transacted."

EDWARD NETTLESHIP PRIZE.

On the occasion of Mr. Nettleship's retirement from practice in 1901 a fund was inaugurated by his friends and pupils, with the object of founding an Edward Nettleship Prize for the Encouragement of Scientific Ophthalmic Work, and at a meeting of the General Committee of the above fund on July 2nd, 1902, the following resolutions were adopted:

1. That the prize should be a Gold Medal for the encouragement of scientific ophthalmic work.

2. That the Council of the Ophthalmological Society of the United Kingdom be asked to undertake the custody of the Prize and Fund, and to appoint Trustees.

3. The award of the Medal shall be entrusted to three members of the Ophthalmological Society appointed by the Council, such members to be changed after each award.

4. That the Medal shall be awarded at such intervals as shall be determined upon.

5. That only British subjects be eligible to receive this Prize.

6. That, subject to the discretion of the said Council, the Prize shall be awarded—

(*a*) For the most valuable contribution to Ophthalmology during the three years immediately preceding or since the last award, or

(*b*) For the best work done on any subject previously selected and announced by the Council of the Ophthalmological Society.

7. That in the event of no work being found of sufficient merit an award shall not be made.

Resolution of Council, January 25th, 1906.

"It shall be lawful for the Trustees, with the consent of the Council of the Society, to expend any surplus arising from the non-award of the Medal in any one year, or accumulated during several years, in the purchase of works for the Library of the said Society, such works to be inscribed 'Purchased by the Nettleship Prize Fund'; or, with the consent of the said Council, to expend such surplus in any manner calculated to promote the objects of the Society as defined in the Rules."

N.B.—Additional trustees, in accordance with the terms of the Trust Deed, have to be appointed by some person nominated by the Council.

BYE-LAWS CONCERNING COMMUNICATIONS.

1. The 'Transactions' shall consist of such communications made to the Society, or to affiliated Societies, by or through

members, as may be deemed by the Council suitable for publication. Also of discussions of importance or interest arising out of such communications.

2. No communication to the Society shall occupy more than twenty minutes, and in the subsequent discussion of it no member shall speak more than once, or for more than ten minutes, without the special permission of the Chairman.

3. All communications accepted by the Society become the property of the Society.

4. Communications are admissible which may have been read elsewhere, provided they have not been published.

5. The cost of illustrations shall be borne by the Society so far as, in the opinion of the Council, is consistent with the state of its funds.

6. Reprints of papers may be obtained by authors at their own expense, by arrangement with the printer.

REGULATIONS CONCERNING THE EXHIBITION OF PATIENTS AND OF PATHOLOGICAL SPECIMENS BY CARD.

A. A card, provided by the Society, must be placed conveniently near the patient (unless it is undesirable that it should be read by the patient or friends), and on it must be clearly written an account of the case, *comprising all the particulars intended for publication*. The title only of the case will be announced by the President to the meeting, but the Exhibitor (or his representative) must be present at the meeting, and be willing to read the case and furnish additional details if called upon to do so; the length of such oral communications not to exceed five minutes.

B. Pathological Specimens may, at the discretion of the Exhibitor, be shown by card, and will then be subject to the above regulations. It is particularly to be noted that the description on the card must *comprise all the particulars intended for publication*.

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REPORTS.

I. PRESIDENTIAL ADDRESS.

The personal equation.

By J. Herbert Fisher.

Ladies and Gentlemen,—My first duty is to welcome those who have been good enough to attend the opening meeting of this Congress. It must be obvious to everybody that the difficulties of assembling in London at this time are very great, and to those provincial members who have come a long distance we extend an especial welcome, and we greatly appreciate the efforts they have made. Perhaps our greatest recompense is, that having got here, there is grave doubt as to whether they will be able to get back.

And now my privilege is to "read myself into office" and deliver my Presidential Address.

I have taken as a title for my introductory address "The Personal Equation." My own equation includes a factor of diffidence and self-distrust, which, while I may with more or less success have concealed it from my associates, has added nothing to my professional happiness. It is, however, an element which tends, I believe, to conscientious effort to perform each duty if we recognise that we are but agents to discharge the ordered purpose of the world. Naturally, as I take the chair of this distinguished Society for the first time, a self-consciousness—not, I trust, morbid or enervating—obtrudes itself

upon me with unusual force. I ask myself for what reason this great honour, the greatest which can be offered to any ophthalmic surgeon in the United Kingdom, has been conferred by you, Ladies and Gentlemen, upon me. I do not propose to reveal to you the answers to that question which have from time to time floated through my mind. When I recall the great names of the past Presidents of this Society I feel the more unworthy. It is to me especially gratifying that you have thought me in turn fit to preside in the chair which has been occupied in the past by my immediate colleagues, Nettleship and Lawford, and that I am now adding a third St. Thomas's Hospital link to the chain of office. The honour is very great; the recipient very unworthy; his thanks, however inadequately expressed, are as unbounded as his heart is full; his responsibilities for the present and future success of this Society are heavy; his confidence that he will receive your kindly consideration and loyal support contribute to give him courage for the discharge of them. Thoughts follow thoughts—in my mind warm gratitude smothers them all. Let us proceed to the practical business of our Congress in the firm conviction that in duty done and work accomplished lie the roots of true happiness and of assured success.

How entrancing a subject is ophthalmology! Whence comes its charm? The complete ophthalmologist does not and cannot exist. When perfection is obtained there is nothing more for which to strive; incentive to further effort exists no longer; we have but to drink deeply of the cup of admiration, and then to sleep. Let no ophthalmologist fear lest thus he attains rest. The subject is wide as the heavens, deep as the ocean; he would be a superman indeed who could encompass it. To comprehend ophthalmic science as now it exists we must perforce enlist as allies the mathematician, the physicist, the chemist, the physiologist, the anatomist, the physician, the surgeon, the urologist, the rhinologist, the dentist, the gynæcologist, the neurologist, the radiologist, the pathologist, the

bacteriologist. At the centre of this vast system in the practice of our branch of the profession sit the clinical ophthalmologists. Small wonder but great gain it is that one is attracted to the medical aspect of the work, another to the surgical; one inclines to physiology, another to pathology; all are contributing to the quota of knowledge, and advancing a subject of compelling interest and of supreme importance to the well-being of mankind. Within the ambit of ophthalmology there is room for every man to exploit to the full the gifts and inclinations with which he is endowed.

New ideas, new methods of investigation and of treatment are continually crowding in upon us. Perimetry and the examination of the central field for colour defects, absolute and relative scotomata are playing larger parts in our investigations; it behoves us to remember the personal equation, when we are employing these methods, if right value is to be attached to their results. One investigator's charts will rarely be found to coincide with those of another on the same patient. Only when a surgeon has stereotyped his own personal equation, and controls that of his patient, will his results on the same case at successive dates be reliable for clinical purposes. Comparative records even of acuteness of central vision must be misleading as to the progress or amelioration of disease, unless at every testing the best effort is exacted from the patient.

Tonometry is tending to replace digital estimation of intra-ocular pressure. It is for the younger generation of ophthalmologists to explore its value; not yet will it quench the older method, if so be the latter is rationally employed. Do we all estimate tension by making our pressure as vertical as possible? Is the interval between the two compressing fingers identical when we apply them over the two eyes? or do we ever try to compare the intra-ocular pressure of one eye with the lateral mobility of the other? Should we not eliminate a source of error if we kept the two fingers always in juxta-

position? The absolute indication for or against operation in a case of chronic glaucoma will never be determined by such variables as the readings on a tonometer or the shape or fluctuations of the blind spot, though in practised hands these observations should be a useful supplement to the well-trained clinician.

The *mise en scène* is ever changing. I am old enough to have seen antiseptic surgery in its childhood, watched its priceless growth, and its replacement by aseptic methods. Bacteriology, phagocytosis, opsonins, vaccine therapy, wax and wane and find their values. X-rays and radium, if they have not fulfilled all our expectations, have added to our capacity in diagnosis and in treatment. Ionisation has perhaps been less successful. Wassermann reactions and Ehrlich's therapeutic methods are of much assistance, but time and experience disclose their limitations and stimulate the search for further advance. Tuberculin in its various forms, supplemented by the work of Calmette and of von Pirquet, perhaps has passed its zenith. Quite lately we have been told that "tetanus and gas-gangrene bacilli washed clean and injected are innocuous. The injection of a few milligrammes of an ionisable calcium salt at the same or a different site, at the same time, or even three months later, secures infection. The calcium ion is specific in breaking down the tissue-cell defence." "Bacteria are not *the* cause, only the exciting cause, of bacterial infections; a third factor, or third partner, acting not on the germ, but on the human host, precipitates disaster." Sensory nerves, it is being contended, appear first in the periphery of the somatic element, and growing thence, eventually join each with its own appropriate segment of the central neural system; it seems doubtful whether the retina, as far as its conducting elements are concerned, is not thus developed, and whether it should any longer be regarded as an offshoot from the anterior primary cerebral vesicle. New drugs and old drugs in new and not always improved forms are thrust upon us. In such a welter moves the

clinician: anxious to be efficient as a healer, scientific in method, a steadying influence, but no drag on progress, it behoves him at all times to get a grip of his case, to be clear in thought and precise in exposition if he is to play his part.

There are, however, other reasons which make ophthalmic work special and unique in its attraction. In all medicine a piece of clinical work is satisfying when the subjective symptoms are reconciled with the objective signs. In most branches the symptoms are definite, the signs are vague: in ophthalmology the converse obtains; the symptoms narrated by the patient are ambiguous, the objective signs are precise. In my own experience, after a thorough catechism of the patient, I have often remarked to my hearers that the evidence suggests a detachment of the retina, or an arterial obstruction, but that probably with the ophthalmoscope we shall find that it is neither the one nor the other. The certainty with which we can examine the eye does not absolve us from getting the clearest possible exposition from each successive patient. The ardent refractionist may easily become so imbued with his powers, that concentrating on the 0·25 D. of astigmatism he strains at a gnat and swallows a camel, and in accomplishing so grotesque a performance, has never taken the time or the trouble to learn from his patient the practical difficulty which led him to seek advice.

Too often we are confronted with the highly myopic sempstress or clerk, incapacitated in the later years of working life by failing vision. A little guidance given to the progressive myope about to embark upon the serious business of life, a suggestion as to suitable employment, may save such a one from a life of misery ending in shipwreck; compared with such help the most perfect retinoscopy is of little value. The blame is not entirely to the ophthalmic surgeon. The last thing the average patient will tell you is the object of his visit. Symptoms possible and impossible he will garrulously emit; and here comes in the personal equa-

tion of the surgeon ; the bit needs to be inserted in the patient's mouth, the guiding rein to be held in the surgeon's hand. The hand should be light but firm ; guidance always, restraint not infrequently is necessary ; the surgeon needs to impose his will, yet so as not to exclude what may be of importance. If such control is needed in elucidating the symptoms, in order that all and only relevant facts may be stated, it is even more important when we employ subjective methods of investigation. How much time is cut to waste in trying to reconcile an acuity of $\frac{6}{12}$ with the objective findings, fearful that something has been overlooked, when under a more stern discipline the expected $\frac{6}{9}$ or $\frac{6}{6}$ is readily forthcoming ? Working on such lines all that can be learnt is ultimately pieced together : objective examination, full, complete and thorough, is now brought to bear ; in no other branch of medicine can we be so absolute. Granted that the preliminary investigations have been well conducted, there should be a ready harmony ; a piece of good work has been done ; we are well on the road to confer the greatest possible benefit—and nothing less should give us satisfaction—upon a patient. The observer needs to be equipped mentally and technically to the best advantage, and to proceed on well-established lines. In no other organ of the body than the eye is it given to the clinician to view the pathological process in actual progress ; by focal illumination, with the loupe, under greater or less magnification with the ophthalmoscope, disease is studied and observed by the surgeon in a way available to no other branch of our profession. We are proud to be called in by our colleagues, to clinch with our objective methods their suspicions of grave local or general disorder. Cerebral disease, arterial degeneration, renal disorder are but a few instances. I was, on one occasion, requested by a distinguished surgeon to express an opinion as to whether it would be possible to preserve the eyeball while excising a rodent ulcer which involved extensively the frontal region and the roof of the orbit.

Corneal nebulæ associated with iritic adhesions led me to the discovery of the scars of disseminated choroido-retinitis, peripherally situated in each fundus; the growth melted away and soundly healed with the administration of the large doses of iodide of potassium which I suggested. I sometimes wonder whether all the cases of osteitis, arthritis and glands of the neck, which are submitted to operation as tuberculosis, are of this origin. I have certainly seen some with unmistakable evidences of interstitial keratitis. I recall a case of severe albuminuric retinitis, where the discovery of pigmented scars disseminated in the choroid coats led me to recommend the administration of antisyphilitic remedies, not excluding mercury. Remarkable benefit, both general and local, followed the treatment. The interstitial fibrosis of the kidneys was presumably of syphilitic origin. Treatment of another patient for disseminated choroido-retinitis was followed by a totally unexpected result: a patient of mine receiving inunction in hospital developed evidences of very serious heart-block and in a few days the case terminated fatally; the scar of a shrinking gumma was discovered post-mortem in the bundle of His; as an inflammatory exudate it had not offered any obstruction to the transmission of the auricular impulse.

That we might be in certain cases able to give the fullest assistance to our neurological colleagues an absolute method of proving, in cases of hemianopia, the presence or absence of Wernicke's pupillary reaction would be of much assistance. I believe we have such a method in the following procedure: The patient is stood at right angles to the plane of a well-lighted window; the observer, facing his patient, covers the eye remote from the window with one hand. Alternately shading and unshading with the other hand the eye next to the window, he notes the pupillary response obtained; having turned the patient through 180° (right about turn) he repeats the same procedure, and observes whether the response of the pupil now under observation is greater or less than that of the

first eye tested. The parallel rays of light impinge in each instance on the nasal half of the retina ; homonymous halves are not stimulated in the two observations ; any difference in the response of the two pupils indicates the presence of Wernicke's reaction. The test is perfectly simple in its application ; the two pupils will react equally if the lesion causing the hemianopia is above the primary basal connections of the optic tract. In a case where the lesion involves the optic tract, the pupil on the side opposite to the lesion gives practically no response at all ; the pupil of the eye on the same side as the basal lesion responds briskly ; there is no uncertainty about the observation. By this simple method the Wernicke's pupillary reaction can be proved absolutely, and full value can be attached to it, whether a positive or a negative result is given.

I cannot help feeling that a closer co-operation with our colleagues in general medicine and surgery is desirable. The gain would be mutual. Let us, however, see to it that we keep our own house in order. The old clinical methods have stood the test of time. The student must be taught to realise that in dealing with his patients he has responsibilities which he can transfer to no other ; the family history, the objective observation of the patient from every standpoint, the present state in all its bearings, demand all his trained acumen. Laboratory investigations may supplement his work ; they are no substitute for it. Thorough catechism of a patient pursued on intelligent lines is essential to good practical work ; the faculty of clinical observation well employed is at least as good as a blood-test. Absolute conclusions will never be reached where premisses are variable. The student of to-day is too apt to lean at every angle for support by others. Let us remember to teach him that he must be able to stand erect by himself. Under schemes being formulated by the Ministry of Health, in view of diplomas in ophthalmology of none too high a standard, much responsibility will rest with the teachers of our subject.

The higher degrees now being instituted in ophthalmology can take care of themselves and can be nothing but an advantage; the like can hardly be said of lower-grade qualifications. The study of disease in the eye can be undertaken only by those who have first been trained in every branch of medicine and of surgery—no compromise can be made. Ametropia and its results cannot be surrendered to the optician; physiological working, not visual acuity, is the goal of the refractionist; all discovery and advance in refraction work has been made, as inevitably it must be made, by the surgeon; $\frac{6}{6}$ is no proof that the most serious, or indeed that any, disease of the eye is not present. My old and distinguished teacher, Edward Nettleship, used to say that no man could say even as much as whether a fundus appearance was physiological or pathological until he had examined 2000 normal eyes.

The band of original members of our Society grows smaller year by year. Since the last Congress we lament the loss of Charles Higgens. Cheery, ever in the middle of the path of open straightforwardness, scathing in denunciation of everything that was doubtful or devious, he fulfilled his mission and passed on. On the eve of our meeting H. E. Juler has been called to rest. In the presence of his son, our Hon. Secretary, it would be difficult, perhaps inconsiderate at so short an interval, to say everything that should be said about him. He leaves a vacancy; many of us may aspire, but who of us can hope to fill it? Let us hold fast our inheritance, cherish it, nurture it and hand it on. Individually let each one of us try to add his quota to knowledge of our subject. In bulk, let us assemble to interchange ideas, to discuss problems, to advance and to refute arguments—in a word, to find out truth in friendly rivalry. Where better than in the meetings of this Society, the Ophthalmological Society of the United Kingdom?

II. THE BOWMAN LECTURE, 1921.

Changes in the visual organs correlated with the adoption of arboreal life and with the assumption of the erect posture.

By E. Treacher Collins.

Mr. President and Gentlemen.—We are assembled here together this afternoon to do honour to the memory of a great scientist, of a great surgeon, of the first President of this Society and its munificent benefactor, Sir William Bowman.

It is a great privilege to have been chosen by your Council to address you on such an occasion, and in selecting a subject for my lecture I have chosen one which would have profoundly interested him whose name it bears and to whom it is dedicated.

The influence of the environment in the production of changes in the visual organs is a large and interesting subject—so large that it is only possible to attempt dealing with a comparatively small part of it in this lecture. The part most full of interest to this Society must necessarily be that which concerns the higher mammals. A study of the morphology of their visual organs shows that there is a very close resemblance between those of man and monkeys, and some very wide differences between those of monkeys and the lower mammals. The chief cause of these marked changes is, I propose to show, to be found in the alteration in environment produced by the adoption of arboreal life.

Dr. Wood Jones (1) in 1915 delivered a lecture at the Royal College of Surgeons "On the Influence of the Arboreal Habit in the Evolution of the Reproductive

System," and I cannot do better than quote here the following passage from his opening remarks :

"No doubt the assumption of the upright posture has done much in putting the finishing touches upon the evolution of the human stock, but we must be careful to give it no more than its real value. Long before the fashion of walking upright had been even foreshadowed in the crouching gait of the half-finished product, a potent factor was at work producing those changes which ultimately permitted, and culminated in the erect carriage. This factor which paved the way, and to which most of the general changes of human and primate bodily conformation are due, was undoubtedly the arboreal habit, the habit of climbing and living up trees, instead of dwelling upon the ground beneath. We are too apt to lay too much stress upon man's descent from the branches. It was not coming down the tree that was so important in the evolution of the human stock ; it was the climbing up, the first step towards the freedom of the branches, that counted in the progress of the mammalian stock from which man has sprung."

In this first lecture Dr. Wood Jones confined his observations to the evolution of the reproductive system, but at its close remarked "that every system and every part of man's body tell the same story." In three lectures delivered the following year he extended the subject, and dealt with the influence of the arboreal habit in the general evolution of man. It is my purpose in this lecture to discuss its influence in the evolution of the visual organs.

The life of mammals in their struggle for existence may be compared to a prolonged game of hide-and-seek. Some, like the Rodentia, have found safety by burrowing in the ground ; some, like the Cetacea, by adopting aquatic life ; some, like the Quadrumana, by climbing up into the trees ; and others, like the Ungulata, by living in herds and acquiring protective coloration. The adoption of life in herds and protective coloration is a game at which two

can play—the attackers and the attacked. Some of the Carnivora hunt in packs, and most of them have acquired colours and markings which serve as effective camouflage in the districts which they inhabit. For this great game of hide-and-seek the sense-organs have become developed to different degrees in the various classes of mammals in accordance with their environments.

The herbivorous terrestrial mammals, whose safety and survival depend upon their swiftness of flight from danger, such as some of the Rodentia and the Ungulata, require sight, smell and hearing so developed as to enable them to detect quickly the approach of danger over a wide area. They grasp their food directly with their mouths, finding that which is suitable more by smell and by the touch of their acutely sensitive snouts than by sight. Their visual organs must, therefore, be adapted for the widest possible range of circumferential vision, sufficiently acute over a wide area to enable them rapidly to detect any moving object—such vision as is aptly termed "panoramic vision"; the highest perfection of which may be described as vision which enables an animal to see in its entire circumference at one and the same time. They also require, to protect themselves from the evils which prowl by night as well as by day, a capacity for seeing in dim as well as in bright light.

The terrestrial carnivorous animals, with their powerful development of tooth and claw, require for their sustenance and survival smell and sight, which will enable them to track their prey and pounce accurately upon it when within a suitable distance. They grasp their food with their mouths, steadying it with their front paws whilst tearing it to pieces with their teeth. Their visual organs must, therefore, be so adapted that they can concentrate the sight of both eyes on their victims at the distance from which they spring, and follow quickly any movements such victims may make in their endeavours to escape. For these purposes binocular vision is more essential than panoramic vision. As the animals upon which these

Carnivora prey are comparatively large, accurate vision for fine detail is not requisite. Good vision in dim lights, rather superior to that of their victims, is essential for success in their pursuits.

Mammals like the Simiæ, who have found safety from carnivorous foes by life in the trees, have in learning to climb acquired the capacity of using their fore limbs for prehensile purposes. They require sight which will enable them to swing and spring with accuracy from bough to bough. Assuming the semi-erect posture, they grasp their food with their hands and convey it by them to their mouths. Their visual organs have, therefore, to be adapted for considerable accuracy in the judgment of distances, varying considerably in degree ; hence not only binocular vision but stereoscopic vision is required, together with accurately associated powers of accommodation and convergence. As the food of these arboreal mammals consists of fruits and insects, which they pick up with their fingers, they require colour-sense and a high degree of acuity of vision for small objects. Safe in their arboreal resorts, away from the dangers which prowl by night in the land below, vision in dim lights is not so essential for their safety as it is for some other classes of mammals.

Man, having descended from the trees and become a hunter and also exposed to the attacks of carnivorous foes, has succeeded in maintaining his existence by the assumption of the erect posture, which has entirely freed his fore limbs for the use of weapons of offence and defence. The manufacture and use of such weapons has necessitated increased precision in the judgment of distances, and of concentration in the thoughtful recognition of detail. The elevation of his head, due to his erect posture, has increased his range of circumferential vision. Having acquired during arboreal life a more acute central form-sense than any other terrestrial mammal, together with the most highly-developed stereoscopic vision, he has, by extended and more rapid movements of both eyes and head, increased the range of his field of fixation.

The different visual requirements thus outlined for different forms of environments have involved considerable alterations in the structural architecture of the visual organs. It is with these structural alterations that I now proceed to deal, dividing them up for descriptive purposes under the following headings: I. The Field of Vision; II. Light-sense; III. Form-sense; IV. Accommodation and Convergence: V. Colour-sense; VI. The Protective Mechanisms of the Eyeball.

I. The Field of Vision.

In studying the modifications met with in the visual organs in the various species of Mammalia, to allow for different requirements in connection with the visual field, we have to take into consideration the monocular field, the combined monocular fields, the binocular field, and the field of fixation.

The extent of the monocular field may be modified by the degree of prominence of the eye in the head, and by structural alterations in the eye itself.

In animals in whom a large monocular field is of the greatest importance, such as those who depend for safety on their rapidity of flight, the eyes are found set prominently out from the surface of the head. In the Ungulata the outer margin of the orbit is composed of a complete projecting bony ring which serves to hold the eyeball prominently forwards. In the Rodentia, the Insectivora and the Carnivora the orbital ring is incomplete externally, in the latter the malar and frontal apophysis being only united by fibrous bands.

The evolution from an incomplete to a complete bony ring at the margin of the orbit can be well traced in the ancestry of the horse. In the *Meso-hippus bairdi*, its three-toed ancestor, from the lower Miocene tertiary of North America, the bony wall of the orbit is open behind.

In monkeys, anthropoid apes and in man the bony apophyses of the outer margin of the orbit are in con-

tact, and it is shut off from the temporal fossa by the orbital plates of the malar and sphenoid bones, so that the orbit becomes a more complete bone-lined recess than in any other class of mammals. In some lemurs a similar separation of the orbit from the temporal fossa is met with, but in the majority of them no such complete separation has taken place. The closing in of the outer wall of the orbit in Primates does not give prominence to the eye and enlarge the monocular field as in the Ungulata, but ensures steadiness of the movements of the eye in the interests of binocular vision.

Some mammals have the power of markedly increasing the prominence of the eyes in the orbit, and so temporarily of increasing the extent of their monocular fields. In burrowing animals, such as moles and hedgehogs, the eyes are retracted, for the sake of protection, when they are below ground, and are protruded, beyond their epidermal coverings, when they come to the surface. In other mammals increased prominence of the eyes becomes most noticeable when they are alarmed, and when increased circumferential vision is most likely to be of importance to them. The increase in the prominence of the eyes is effected by relaxation of the retractor bulbi muscle, and contraction of the muscle of Gegenbauer, which lines the fibro-elastic tissue filling in the outer wall of the orbit in animals where it is not bounded by bone. A vestige of this muscle is sometimes to be found in man opposite the spheno-maxillary fissure, and is termed Müller's muscle. I shall have more to say respecting it later, in speaking of the protective mechanisms of the eyeball. I refer to it here because slight protrusion of the eyes in human beings, as the result of intense emotional excitement, has been observed; though "starting of the eyes from the head" as the result of fright is more often read of in fiction than actually seen in real life.

An increase in the size of the cornea relatively to the size of the eyeball must allow rays of light of greater obliquity to be refracted into the eye, and an increase of

the corneal surface tends to increase not only the size of the field of vision, but also the clearness of peripheral images.

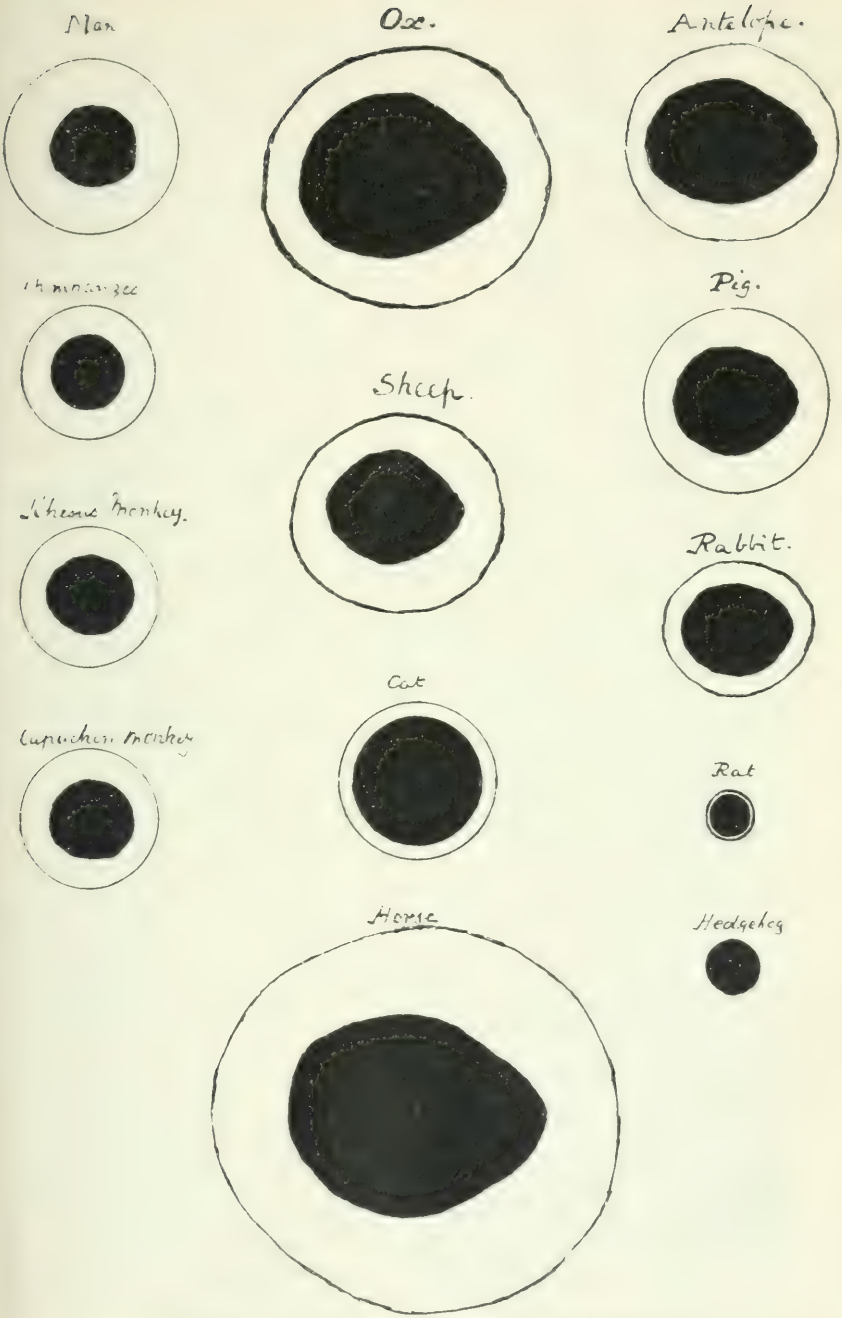
In some rodents the cornea composes nearly half the surface of the eyeball. The relations between the diameters of the eyeball and the cornea of mammals are shown in the following table. (See Fig. 1.)

	Diameters of the eyeball.		Diameters of the cornea.	
	Antero-posterior.	Lateral.	Lateral.	Vertical.
Man	24·8 mm.	24·4 mm.	11·6 mm.	11·0 mm.
Chimpanzee	19·0 „	18·0 „	10·5 „	—
Rhesus monkey	19·5 „	19·0 „	12·0 „	11·0 mm.
Capuchin monkey	18·5 „	19·0 „	11·0 „	10·5 „
Cat	22·0 „	21·0 „	18·0 „	—
Horse	44·0 „	54·0 „	34·0 „	27·0 mm.
Ox	36·0 „	38·0 „	27·0 „	22·0 „
Sheep	27·0 „	28·0 „	19·0 „	15·5 „
Antelope	27·0 „	29·0 „	22·0 „	18·0 „
Pig	23·5 „	24·0 „	17·0 „	14·0 „
Wallaby	18·0 „	19·0 „	14·0 „	—
Rabbit	16·0 „	20·0 „	15·0 „	—
Rat	5·5 „	5·5 „	5·0 „	5·0 mm.
Hedgehog	6·0 „	6·0 „	6·0 „	6·0 „

In man and monkeys, where a central spot of distinct vision is of the greatest importance, the size of the cornea relatively to the size of the eyeball is comparatively small. Thus in all mammals below man the diameter of the cornea measures more than half the antero-posterior diameter of the globe. In the chimpanzee it is about half and in man considerably less than half.

Mammals that have a proportionally large cornea have also a proportionally large lens which is nearly spherical in shape, there being only a very slight increase in the size of the lateral diameter over that of the antero-posterior (*vide* table, p. 55). In man and monkeys, where the cornea is proportionally small, the lens is also proportionally small and considerably flattened from before backwards. In monkeys the antero-posterior

Fig. 1



Showing size of cornea in relation to size of eyeball.

diameter of the lens is a little more than half the lateral diameter and in man about half.

Emmert (2) has estimated the relation of the size of the lens to the size of the eyeball as follows;

Horse	6 to 100.
Ox	7 to 100.
Calf	5·5 to 100.
Sheep	7·6 to 100.
Pig	8 to 100.
Dog	7·7 to 100.
Cat	10 to 100.
Rabbit	8 to 100.
Man	4·2 to 100.

As pointed out by Lindsay Johnson (3), with a large spherical lens, rays falling obliquely on the cornea will be brought to a focus with comparatively little distortion, the image being received upon a surface which is nearly equidistant from the nodal points. This is a matter of considerable importance in securing a large monocular field for moving objects, in animals with a retina having a widely-extended sensitive area. In the Primates, who require acute vision for small fixed objects, and who have developed a highly sensitive, small, central spot for this purpose, it is essential that the image of the object looked at should be accurately focussed on that spot only. It is advantageous, in the interests of binocular vision, that the images of objects formed on parts of the retina peripheral to the central spot should be but dimly seen. Hence we find in the Primates the cornea and lens so constructed as to sacrifice the interests of the monocular field in favour of those of acute central fixation.

The alteration in the shape of the lens in Primates, so that instead of being nearly spherical it is considerably flattened antero-posteriorly, has considerably diminished its refractive power. To compensate for this to some extent we find that the refractive power of the cornea has been considerably increased. The following interesting table has been constructed by Kalt and Dufour (4); it

shows that in the eyes of man and birds, which have flattened lenses, the refraction of the cornea relative to that of the lens is considerably greater than it is in other mammals and in fishes, which have rounder lenses.

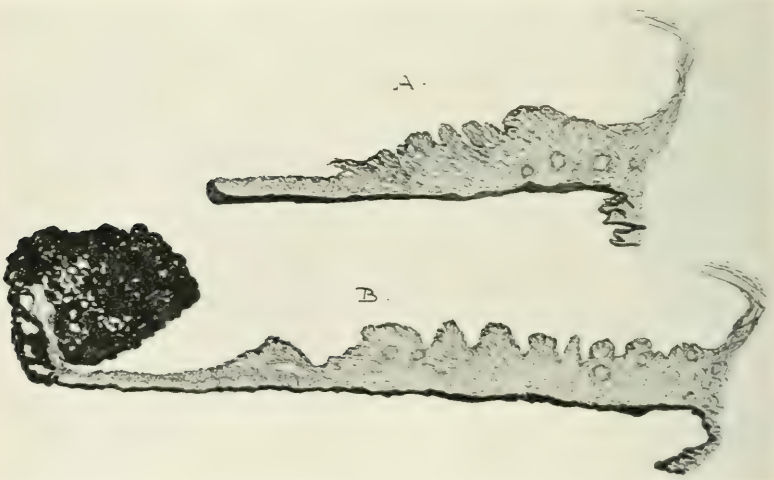
	Focal distance of the cornea.	Focal distance of the crystalline lens.	Relation : 1 to—
Man	31·2 mm.	49·2 mm.	1·60 mm.
Crow	25·8 ,,	36·7 ,,	1·42 ,,
Horse	78·8 ,,	64·4 ,,	0·82 ,,
Dog	33·8 ,,	22·9 ,,	0·60 ,,
Whale (out of water)	314·3 ,,	40·5 ,,	0·13 ,,
Carp	38·0 ,,	6·6 ,,	0·17 ,,

Most of the Ungulata have markedly oval corneæ, their lateral diameters measuring more than the vertical. In sheep there is a difference of 3·5 mm. between the two, and in the ox 5 mm. Associated with oval corneæ they have oval pupils elongated laterally. According to Eversbusch, this is due to the presence of a check ligament, extending from the pupillary margin to the periphery, which can be seen as an elevation on the posterior surface of the iris. I have examined the iris of several different species of Ungulates, but have been unable to find any such check ligament. The elongation of the pupil can quite adequately be explained : First, by the elongation of the cornea, to which the root of the iris is attached laterally ; and secondly, by the length of the iris in the vertical plane being greater than in the horizontal. In a horse's iris I find there is 2 mm. difference in the length of the iris horizontally and vertically (Fig. 2). There is also, in these animals with a horizontally oval pupil, a difference in the length of the ciliary body horizontally and vertically. In the horse the distance from the root of the iris to the ora serrata measures 5 mm. horizontally and 10 mm. vertically. To put it another way, the retina extends further forwards laterally than vertically in the Ungulata, which have pupils and corneæ elongated laterally. The

combined effect of these three anatomical features is to produce an extension of the monocular field of vision in the horizontal plane.

In the centre of these elongated oval pupils a deeply-pigmented elevation is met with at both the upper and lower borders, but considerably larger and more raised at the upper than the lower (Fig. 3). This elevation has

Fig. 2.



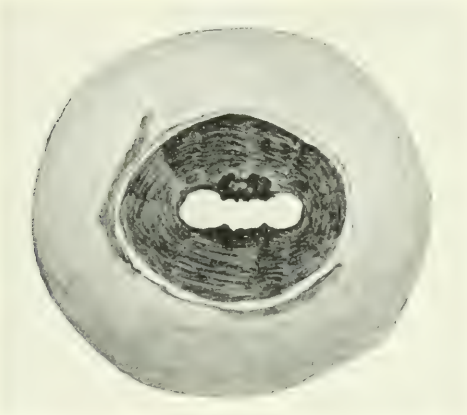
Sections through the iris of a horse. A. In the horizontal meridian. B. In the vertical meridian.

received the name of the "corpus nigrum." In a horse, the lateral diameter of whose pupil measured 17 mm., the corpus nigrum at its upper border measured 8 mm. in length, 3 mm. in width, and 3·5 mm. in height. In sections of the iris it can be seen to be an extension forwards from the pigment epithelium on its posterior surface, *i. e.* a growth forwards from the anterior extremity of the secondary optic vesicle (Fig. 2 B). It is a vascularised structure and so has some elements of mesoblastic tissue in it. Bleached sections show the mass to be made up of

flattened epithelial cells, which line and form columns between numerous, variously sized circular spaces.

The function of the corpus nigrum has so far not been definitely determined. Lindsay Johnson (3) suggested that it served as a shade for the large oval pupil. Such a suggestion does not explain the presence of a projection from the lower margin of the pupil as well as the upper. In some animals, *e. g.* gazelles, camels and llamas, the

FIG. 3.



Front of horse's eye from which cornea has been removed to expose iris with the "corpus nigrum."

black bodies from the upper and lower margins of the pupil have indentations capable of fitting into one another. On examination of horses' eyes, when exposed to bright sunlight, I have observed that contraction of the pupil causes the pigmented bodies from the two borders to meet and fill up its centre, leaving the two extremities still open. So that the horse then has, instead of one oval pupil, two circular ones, looking respectively forwards and backwards. A large oval pupil, whilst affording a wide range of lateral vision, must detract very considerably from the clearness of vision by not having the stenopaic

effect of a round pupil. I would suggest that one function of the corpus nigrum is at times to compensate for this defect by the conversion of the oval pupil into two round ones.

Animals, such as the terrestrial herbivorous mammals, who require panoramic vision, have their eyes set laterally in the head so as to obtain the largest circumferential effect of the combined monocular fields. Lindsay Johnson (3) measured the divergence of the optical axes in a large number of representative animals, and constructed a diagram graphically showing how it varies in the different natural orders, families, genera and species. From this it is seen that the most laterally placed eyes are met with amongst the Rodentia, the Marsupialia and the Ungulata. The greatest divergence is in hares, whose optical axis in each eye measures 85° of divergence from the middle line. It seems probable that they, and some of the other rodents, have complete panoramic vision, *i. e.* are able to see in their entire circumference at one and the same time.

Amongst the Carnivora the smallest amount of divergence is in lions and cats, in which it is less than 10° in each eye. The Simiæ and man alone amongst mammals have parallel optic axes.

This movement forwards of the optical axes towards parallelism is clearly in the interests of binocular vision, and at the sacrifice of the range of simultaneous circumferential vision. As ontogeny is a condensed recapitulation of phylogeny, it is interesting to note that in the human embryo the optic vesicles when first formed are directly opposite to one another, from which position they gradually turn forwards, so that at the third month of fœtal life the optic axes of each eye diverge 45° from the middle line; before birth they become parallel.

Wood Jones (1) has described how the alteration in the position of the eyes in mammals is due to the recession of the snout. He says: "When an animal has a fully elongated snout region, it may be said to possess a long

face with an eye situated upon each side of it; but when the snout region has undergone complete recession, it may be said to have a flat face with two eyes situated upon the front of it. The mere fact of the recession of the snout produces this change, for the two eyes are turned to the front as the elongated muzzle shrinks between them."

He further points out this recession of the snout is the result of (*a*) the substitution of the hands for it as the chief means of tactile exploration; (*b*) the decrease in the use of the jaws for seizing and tearing food; (*c*) the diminished importance of the sense of smell.

The three changes are all the outcome of the adoption of arboreal life. It has resulted in the use of the fore-limbs for grasping purposes. From this they have gradually acquired acute tactile sensibility, and have superseded the snout as a means for exploration by the sense of touch; the latter has, therefore, tended to atrophy from disuse. From the grasping of boughs in arboreal life has arisen the power of grasping food with the hands to convey it to the mouth instead of seizing it primarily with the jaws. This diminished use of the jaws has led to their loss of prominence and power. "No trail of scent is laid among the branches of a tree" (Wood Jones). "Life amidst the branches limits the usefulness of the olfactory organs" (Elliot Smith).

Binocular vision is produced by the overlapping of the fields of vision in the two eyes. In Cetaceans so massive is the head, and so far back are the eyes set, that it is impossible for any such overlapping to occur. In rodents, such as rabbits and hares, which also have their eyes set far back, the overlapping of the fields anteriorly cannot exceed more than 15°.

It has been suggested by Grossman and Meyerhausen (6) that in these animals some overlapping of the fields may occur posteriorly, and that in them a certain amount of posterior binocular vision may be present. As all sportsmen know, rabbits and hares see very imperfectly

when danger is immediately in front of them, and will run straight forwards towards a gun.

In connection with the binocular vision of mammals it is important to note the observations of Kalt (7) as to the size of the angle γ in the different species. He states that "in the human species the visual axis pierces the cornea 5° inside its centre. In the higher monkeys it is almost the same, but one sees this angle increase as one descends the animal scale. It is 15° in the Lemuridæ, 20° to 26° in the Carnivora, and it varies between 55° to 63° in the Herbivora." The increase of the angle tends to balance to some extent an increase in divergence of the optic axes, so that animals with a wide divergence are still able to see binocularly.

A horse with eyes set prominently forwards, large corneæ and laterally oval pupils can see behind and observe the out-kick of its hind leg without turning its head. With a visual axis piercing the cornea 50° to 63° inside its centre, with the corpus nigrum capable of closing in the middle part of the oval pupil and leaving a circular one looking forwards, and with about one-sixth of the fibres of the optic nerve turning into the optic tract of the same side whilst the rest decussate, a horse evidently possesses binocular stereoscopic vision, which must be of the greatest assistance to it in the estimation of size and distance in jumping. Every horseman knows that an object at which a horse is most likely to shy is one situated at the side and of a light colour. To prevent shying we put blinkers on harness horses, so that they may not see these laterally placed objects, but only those which they view binocularly straight in front of them. In training a shying horse it is customary to walk the animal up to any object it has shied at with its head towards the object, which it can then view binocularly.

Closely associated with the varying degrees of binocular vision we meet with varying degrees of decussation of the fibres of the optic nerve at the chiasma. This matter

has been dealt with very fully by Dr. Wilfred Harris (8). He considers that binocular vision is associated with carnivorous habits; it is met with in carnivorous fishes, amphibia and birds. In all these there is total decussation of the optic nerve-fibres at the chiasma, so that they do not have stereoscopic vision as in mammals, in many of whom, owing to semi-decussation of the fibres at the chiasma, visual impressions from the two eyes are received on the same side of the brain.

Rodents have no conjugate movements of the eyes, and no consensual response of the pupils to light, only a direct reaction. Singer and Münzer (9) found that in mice and rats the decussation of optic nerve-fibres at the chiasma was complete. Wilfred Harris examined the optic nerves, chiasma and tracts of rabbits in sections stained with hæmatoxylin by Pal's method, and also a fortnight after the experimental enucleation of one eye, by staining with Marchi's method, to trace the degenerated fibres. He found that decussation was almost complete, only very few fibres, here and there, turning round from the optic nerve into the optic tract of the same side. Ramon y Cajal (10) obtained similar results.

In the Ungulata it is difficult to observe the movements of the two eyes at the same time, but it appears that they are to some extent conjugate. In them the decussation of the optic nerve-fibres at the commissure is not complete. In the horse and calf, two observers in Vienna, using Marchi's method, found that about one-sixth of the fibres turn into the optic tract of the same side.

In the carnivorous mammals there is consensual reaction of the pupils to light, and the movements of the two eyes are more obviously conjugate than in the Ungulata. Wilfred Harris found that experimental division of the optic tract on one side in cats produced distinct homonymous hemianopsia, with the hemianopic pupil reaction to direct light in the opposite eye, though its

consensual reaction was brisk on exposure of the other eye to light. Microscopically, he found, in sections of the chiasma of a cat stained with Marchi's method, after enucleation of one eye a fortnight previously, that a large proportion of degenerate fibres were present in the optic tract of the same side. These degenerate fibres were spread equally through all parts of the tract and not collected into any distinct bundle.

In monkeys and in man there are conjugate movements of the eyes, and consensual reaction of the pupils to light, as in the Carnivora, but in addition they have a very highly developed spot of central vision with a special bundle of nerve-fibres leading from it, and highly developed powers of convergence and accommodation.

There is no very definite anatomical evidence as to the course taken by the macular nerve-fibres at the chiasma. Cajal (10) discovered bifurcating fibres in the chiasma of the rabbit, the divisions passing into the two optic tracts. Kolliker (11) found similar bifurcations in the chiasma of a cat a few days old. It was upon these observations that Wilbrand based his hypothesis as to the escape of the macula in cases of bilateral hemianopsia.

He attributed it to the bifurcation of fibres coming from each macula at the chiasma, so that both maculæ were connected with the occipital cortex on each side. There is, however, no evidence as to where the dichotomous fibres found in the embryo cats come from, and in rabbits' retinæ no specialised central area, such as a macula, can be differentiated.

Usher and Dean (12) traced the course of degenerated nerve-fibres in the optic nerve and chiasma in monkeys after experimental lesions in the retina at the macular region. In summing up their results they say: "As regards the question whether the macular fibres cross wholly or partially in the chiasma, it is impossible from our experimental cases to make a definite statement, owing to the difficulty that exists in determining whether the wound was limited to the macular fibres or, on the

other hand, whether it had damaged only a portion of these; while in Case 11 the decussation was complete, in Case 10 there were uncrossed fibres, even at the most posterior part of the chiasma."

Though the anatomical evidence as to the course taken

Fig. 4.

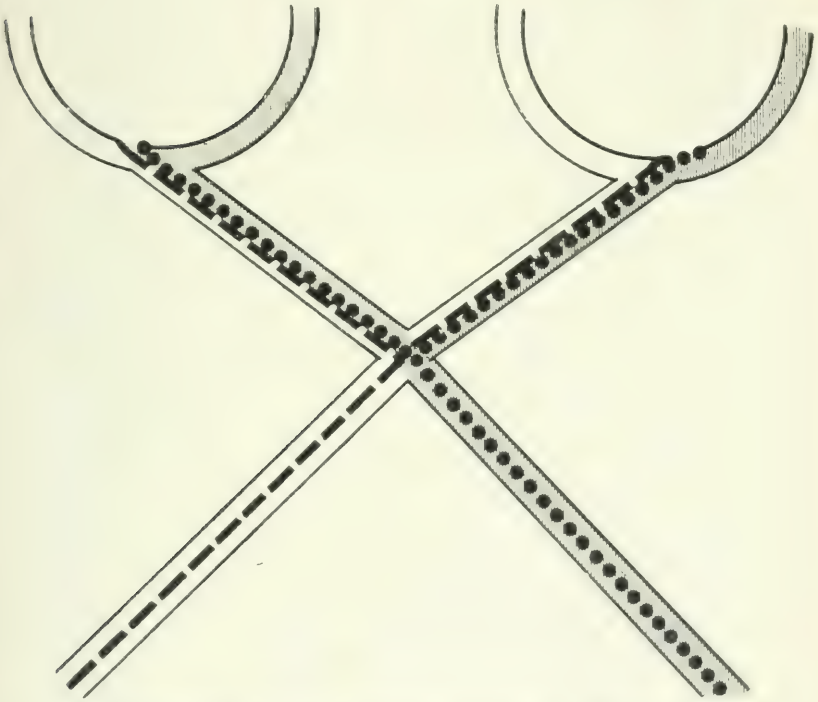


Diagram to show hypothetical semi-decussation of macular nerve-fibres at the chiasma.

by the macular fibres in the chiasma is very uncertain, it seems highly probable, on physiological and clinical grounds, that semi-decussation of them takes place. It would be difficult to understand how stereoscopic vision for detail could be brought about, unless the images coming from objects focussed on each macula were super-

imposed in the visual cortex. It seems most probable that in man and monkeys, not only are the visual impressions received from the left halves of the two retinæ superimposed on the left half on the occipital cortex, and those from the right halves of the two retinæ on the right half of the occipital cortex, but that the impressions received from each macula are similarly superimposed on each half of the brain (Fig. 4). Clinically this view helps us, not only in explaining the "macula escape" in cases of bilateral hemianopsia, but also affords an explanation of cases of central hemianopic defects without any peripheral contraction of the fields, an affection which, if right-sided, has the characteristic symptom of the patient finding a difficulty in reading whilst still retaining good central acuity of vision.

This semi-decussation of the nerve-fibres from each macula is also, I suggest, of interest in connection with the causation of certain cases of congenital concomitant strabismus. As we all know, there are cases in which children have perfect acuity of vision in each eye, with little or no refractive error, who never at any time make an attempt to use the two eyes together, nor can they by any means be induced to do so. A very simple explanation of such cases might be found in a congenital defect in the course of the macular nerve-fibres, whereby complete decussation, instead of semi-decussation, had taken place. With complete decussation the impression received by the visual cortex from each macula would be unilateral instead of bilateral, as with semi-decussation. The acuteness of perception would not be affected by the complete decussation, only the stereoscopic effect. The anatomical evidence in proof of this hypothesis would be exceedingly difficult to obtain. Clinical evidence might, however, be forthcoming should a patient having such a congenital concomitant strabismus subsequently develop a homonymous bilateral hemianopsia, in which case, if this hypothesis be true, we should expect to find the whole macular region on one side included in the blind area.

Conjugate movements of the eyes in the vertical plane are innate in the human infant, but in the horizontal plane are only gradually acquired during the first six months of life.

From the early development of conjugate movements in the vertical plane we may infer that man's mammalian forbears were exposed to dangers which attacked them from overhead, in the way in which small rodents are now attacked by carnivorous birds. The development of conjugate movements in the lateral plane followed later, with the shrinkage of the snout and the translation of the eyes forwards in the head.

The development of acute, central, stereoscopic vision for form, together with corresponding points in the two retinæ, introduces a fresh factor in connection with the field of vision—that is, the field of fixation. Though no mammals below monkeys have a capacity for distinguishing detail, such as is associated with the presence of a fovea centralis, there is evidence to show that in some, especially the Carnivora, there is an area centralis in the retina more acutely sensitive to form than the periphery. Such animals can fix an object and make movements of the eyes to maintain fixation, *e. g.* when a cat follows the movements of a mouse. The field of fixation becomes, however, of greater importance with the increased acuity of central stereoscopic vision, such as has been developed in association with arboreal life. Still more is it important to man, who has assumed a fully erect posture and become exposed to the dangers of terrestrial life by his descent from the trees. The rapid movement of the highly-developed spots with acute form-sense, from one object to another in his circumference, more than compensates man for the loss of the wide degree of panoramic vision which the alteration of position of the eyes from the side to the front of the head entails. For these rapid changes of position of the spots with acute form sense, increased mobility, first, of the eyeballs, and secondly, of the head, has been evolved.

Though nearly all mammals have, as in man, four recti and two oblique muscles connected with the eyeballs, the movements of the globes in all those below monkeys are comparatively slight. It is in association with the development of acute central stereoscopic vision, as in monkeys, that the movements of the eyes become a conspicuous feature. The range of such movements becomes considerably extended in man, and may, I suggest, be correlated with the full assumption of the erect posture and the greater need for a wide, quick circumferential vision on the ground than in the trees.

It is probably for the purpose of increasing the range of movement of the eyes that man has developed a wider palpebral fissure, in proportion to the width of the cornea, than is met with in any other mammal. The effect of this proportional difference is that a large part of the ocular conjunctiva, with the sclerotic beneath, becomes exposed to view. In no other mammal are "the whites of the eyes" such a conspicuous feature as in man. An exposure of the ocular conjunctiva in this way has rendered it liable to irritation from atmospheric influences, more especially on the inner side of the globe, where, due to the presence of the lacrymal bay, the largest area is uncovered, and where, in mammals other than Primates, a special protection is afforded by the membrana nictitans. Irritation of this sort from atmospheric influences, when excessive, gives rise to the diseased conditions known as "pinguecula" and "pterygium"—affections which are not met with in other mammals than man.

Wood Jones (1) has described how the changed relations between the long axis of the skull and face and the long axis of the vertebral column, which is produced in monkeys as the result of arboreal life from the partial assumption of the upright posture, has resulted in a changed position of the occipital condyles on the base of the skull, which hinge it to the vertebral column. In quadrupeds these condyles are situated at the posterior extremity of the skull. In most monkeys they are situated well forward

on the base; in anthropoids still further forward; in man, who has assumed the permanently erect posture, the head is practically balanced upon the first cervical vertebra.

As the head becomes more nearly balanced on the vertebral column, so the powerful ligamentous and muscular attachments which pass between its posterior surface and the cervical spinous processes become reduced in strength, and the spinous processes themselves become reduced in size. The even balancing of the head on the spine, and the reduction in size of the cervical spinous processes, both tend to facilitate the range and rapidity of the lateral and rotatory movements of the head. Such increased movements of the head, like the increased movements of the eyes, serve to increase the area of the fields of fixation.

II. Light-Sense.

The most primitive visual function is the perception of light, and the eyes of some animals are so constructed that this would seem to be the only purpose for which they exist.

According to Prof. Elliot Smith (1), in the forerunners of the Mammalia, and in the primitive mammals themselves, the senses of sight and hearing were but poorly developed compared with that of smell. "This was due," he says, "not only to the fact that the sense of smell had already installed its instruments in, and taken possession of, the cerebral hemisphere, long before the advent in this dominant part of the brain of any adequate representation of the other senses, but also, and chiefly, because to a small land-grubbing animal the guidance of smell impressions, whether in search for food or as a means of recognition of friends or enemies, was much more serviceable than all other senses. Thus the small creature's mental life was lived essentially in the atmosphere of odours, and every object in the outside world was judged primarily and predominantly by its smell,

the sense of touch, vision and hearing being merely auxiliary to the compelling influence of smell."

The smallest and least developed eyes in existing mammals are found in moles, hedgehogs, insectivorous bats, and cave-rats. All of them are nocturnal in their habits, and have only rods in their retinæ—no cones. The visual function in these animals may be attributed entirely to the chemical reaction produced by light on the visual purple, which, through stimulation of the rods, starts a nervous impulse. These animals have a dread of light, or photophobia; when it appears the moles and hedgehogs at once return to their burrows, the rats retreat to the inner recesses of their caves, and the bats into the darkness of the foliage.

The photo-chemical reaction of the visual purple, besides providing for perception of light, could easily be amplified to provide for adaptation for different degrees of light, by the extent of the chemical reaction induced varying in accordance with the intensity of the illumination.

Trendelenberg (13) showed that there is a very close correspondence between the curve of scotopic luminosity in the human eye and that obtained from the bleaching of the visual purple of a frog's eye.

The time which it takes for the visual purple to re-form in the rabbit's retina, after it has been bleached, coincides very closely with that which it takes the human eye to regain the approximately full power of dark adaptation after good light adaptation.

A bleached, undamaged, detached retina will remain bleached, unless brought back into contact with the pigment epithelium, when it will regain its violet colour. From this, and from their anatomical arrangement, we may assume that the pigment epithelial cells are concerned in the manufacture of the visual purple. They are arranged like the cells in other secreting structures on a basement membrane immediately beneath which is a rich vascular plexus, the capillary layer of the choroid. The fanciful suggestion made by Edridge Green (14), that the

visual purple is secreted by the rods, has nothing to support it, either anatomically or morphologically. The rods, from their structure and connections, are obviously not secreting cells, but nerve end-organs.

Numerous careful and accurate observers have recorded how the visual purple is only to be found in the outer limbs of the rods, and not in the cones. I have myself been able to confirm its absence from the cones in the retinæ of frogs and birds.

If, then, the rods react to the stimulus of light through the photo-chemical reaction of the visual purple, some other explanation has to be found for the reaction of the cones. A perception of light dependent entirely on changes in the visual purple would become abolished when it was bleached in bright light, and an animal with only rods in its retina would be blind under such circumstances.

The theory suggested independently by Max Schultze (15), Parinaud, and v. Kries (16), which assigns different functions to the rods and cones, the so-called duplicity theory of vision, helps to explain so many of the visual phenomena met with in the human eye, both in health and disease, that it may well be accepted as a working hypothesis for the explanation of vision in other Vertebrata.

According to this theory the rods come into action in low degrees of illumination. They can only distinguish different degrees of light, not form or colours. The cones, on the other hand, come into action in high degrees of illumination, are capable of distinguishing the spectral colours, and of perceiving clearly the details of form. As Parsons (17) very aptly says: "Broadly speaking, vision with the dark-adapted eye, *i. e.* scotopic vision, is monochromatic or tone-free. Vision with the light-adapted eye, *i. e.* photopic vision, is polychromatic or toned. In the former the threshold stimulus intensity is low; in the latter relatively high."

Prisoners who have been confined in dark dungeons

for a long time, the congenitally total colour blind, the mammals, already referred to, who have only rods in their retinæ, and nocturnal birds, all have a dread of light—that is, photophobia. They are all temporarily or permanently dependent for vision on perceptions received through their rods and the visual purple.

Those who have been exposed for a long time to glare, like sailors becalmed on a tropical sea, those who have the congenital affection which we call "night-blindness," or the acquired affection which is spoken of as "retinitis pigmentosa," and diurnal birds, all have a dread of darkness; that is a condition which I suggest may be conveniently termed "scotophobia." They are all temporarily or permanently dependent for vision on perceptions received through their cones.

No other photo-chemical substance has been discovered in the retina besides the visual purple. It becomes, therefore, natural to inquire whether some reaction other than chemical is not produced in the cones capable of originating a nerve impulse on stimulation by light.

Stort and Englemann (18) have described how a shortening of the inner segment of the cones takes place by the action of light and an elongation in darkness. On exposure to light, therefore, the outer segments of the cones are drawn towards the outer limiting membrane and away from the pigment-cells, while in darkness the opposite movement takes place. This effect has been observed in the retina of all animals hitherto examined, viz. fish, amphibians, reptiles, birds and mammals, including man. The part which moves actively is that which in its optical and chemical properties is like protoplasm, viz. the part of the cone between the ellipsoid and the cone nucleus, and to this they give the name of "cone-myoid." This movement in the cones may be compared with the phototropic reactions met with in plant life, in hydra, and some small worms.

It would be a simple way of explaining the difference in the mode of stimulation of the rods and cones by light

to regard that of the former as a photo-chemical reaction, and that of the latter as a phototropic reaction. Such an explanation would serve not only to account for the differences observed between rod and cone vision as regards light-sense, but also as regards form-sense, as I shall attempt to show in the consideration of that part of my subject. It is true that the contraction which has been observed in the cones resulted from a strong stimulus of some duration, but so far it is the only change of which we have any evidence as occurring in the cones apart from the rods; it is well, therefore, to see how far such a change will help in explaining visual phenomena.

The degree of illumination required to excite a phototropic reaction would be greater than that required to produce a photo-chemical reaction, so that we should expect rod vision, if it acted by the latter, to come into action with lower degrees of illumination than cone vision, if it acted by the former. Rod vision would fail in high degrees of illumination, due to complete bleaching of the visual purple; whilst cone vision, being capable of some degree of adaptation due to a varying degree of contraction of the cone-myoid in response to the amount of stimulating light, might continue active after the retina has been completely bleached.

As already mentioned, the mammals with the smallest eyes, who only expose themselves to very low degrees of illumination, have only rods in their retinæ. Those mammals who, though mainly nocturnal in their habits, enter rather more boldly into the light of day, such as rats, mice and rabbits, are found to have a few cones. Indeed, the amount of daylight an animal exposes itself to and the number of cones met with in its retina correspond fairly accurately. The Simiæ, who, to obtain their food in their arboreal resorts (consisting, as it often does, of minute objects), require a high degree of illumination, have an area of the retina in which only cones are present, and in which they are closely congregated together. It would seem probable that it is due to this congregation of

the cones together at the macula that man and monkeys can stand exposure to brighter daylight than any other mammal. Man's eyes cannot, however, stand exposure without damage to the same degree of direct sunlight as some birds; eagles, for example, as they rise to fly will gaze directly at the sun without flinching. In the diurnal rapacious birds the retina has been found to be richer in cones than any other birds, or than any mammals.

Various means, supplementary to those in the retina itself, have been acquired by mammals to fit them for an environment having low degrees of luminosity. Some deep sea fishes and cave animals, who live in absolute darkness, have no visual sense and no visual organs, their survival depending on the acuity of their other senses. Other deep-sea fishes have evolved their own illuminating appliances, and carry in front of them an apparatus capable of emitting a phosphorescent light. In the eyes of pelagic fishes reflecting membranes are met with; on the surface of the iris is the membrana argentina, which gives it great brilliancy, and acts by reflecting light on objects looked at in dark places, much in the same way as that in which we employ our ophthalmoscopic mirrors. On the inner surface of the choroid they have another reflecting membrane, the tapetum lucidum, which intensifies the power of seeing in dim lights by reflecting rays back on the retina. The same device is met with in several classes of mammals; in the carnivorous Cetaceæ the reflecting membrane, as in fishes, covers the whole fundus; in the terrestrial mammals, where a tapetum is found, it covers only a sector of the fundus external to the optic disc. In the terrestrial Carnivora the tapetum is most brilliant, and is composed of cells arranged in elongated plates together with hexagonal crystals. In the Ungulata the tapetum has an entirely different structure, being composed of layers of fibrous tissue and not cells. Amongst Primates a tapetum is met with in some lemurs with nocturnal habits, and is similar in construction to that of the

Carnivora. Man and monkeys have no supplementary arrangement for seeing in dim lights such as that afforded by a tapetum lucidum. Monkeys, having resorted to arboreal life, where they found their food by day, and where they were safe from the attacks of carnivorous foes by night, have not had to acquire nocturnal habits. Man, having inherited his visual capacities from his arboreal ancestors, found himself, on his descent from the trees, more than equal to his mammalian foes by day, but inferior, and sadly handicapped, by night. Not only had he not acquired the advantages of a tapetum, but from prolonged life in the branches and reduction of the snout he had lost much of the protection afforded by acuteness of smell.

All children instinctively dread darkness and many persons can never free themselves from such dread throughout their lives. O. G. S. Crawford, writing in a recent number of the *Cornhill Magazine* on "Prehistoric Instincts," says :

"Primitive man is an animal that lives and works by day. His habits are not nocturnal, and he seldom by choice goes forth from his lair during the hours of darkness. This love of daylight, and the corresponding aversion to darkness, is probably due to the great reliance he places upon sight; but, of course, the order of causation may have been reversed. We do not, however, find it in dogs, which rely on ear and nose. However this may be, there can be no doubt about the existence of an instinctive dislike of darkness in all of us to-day. This dislike is the pale survivor of a very real and acute instinct of fear innate in us, which dominates our childhood with all the vigour of its original force."

Primitive man, a mighty hunter by day, through the absence of a tapetum became a coward by night. A somewhat parallel instance may be referred to occurring amongst birds. They have no tapetum lucidum in their choroids, but in the retinæ of nocturnal birds rods are found to predominate very largely over the cones, whilst

in the retinæ of diurnal birds the reverse condition is met with, the cones in them being far more numerous than the rods. The small diurnal birds, sparrows, chaffinches, redbreasts and such like, as soon as dusk begins to approach, seek concealment in bushes and hedges, where they will be safe from the dreaded attacks of the night owl. Should the owl prolong his hunting expeditions to such a distance that daylight overtakes him before he can return to his usual retreat, he becomes dazzled, is unable to proceed, and has to remain where he is until darkness again ensues. If during the daylight he becomes discovered by the small diurnal birds upon which he usually preys, they at once recognise his plight and give him no mercy, mobbing him and pecking him with impunity. Thus through the specialised character of the end-organs of the retina the mighty hunter of the night becomes the abject victim of the day.

Primitive man, having abandoned the safety of the trees, sought protection from the perils that prowl by night in the natural recesses of the cliffs, and became a cave-living animal. Gradually he progressed to the hollowing out of caves for himself, and thus acquired the first step which led to the building habit. From this may we not trace the construction of lake dwellings, which by their situation afforded admirable protection from carnivorous foes, and later the more substantial houses of brick and stone, ultimately leading to all the glories of architecture ?

It is probable also that fire, when first discovered by primitive man through hacking iron pyrites with a flint amongst dead leaves (Lubbock), was more valued for its illuminating than its heating properties. By the illumination which it afforded him at night his range of vision would become extended, and his struggle for existence against carnivorous mammals considerably assisted. From this first use of fire as an illuminant we can trace man's gradually increasing means of overcoming the dangers of darkness, until we arrive at the powerful searchlight of

to-day which he employs both for purposes of attack and defence.

III. Form-Sense.

Acuity of form-sense reaches its highest development amongst mammals in the Primates. Mammals as a class are characterised by the absence of a fovea, the Primates being the only ones in which it is to be found. In many mammals which do not possess a fovea there is an area centralis which approaches in structure the yellow spot; this can be recognised ophthalmoscopically, when the retinal blood-vessels are present, by the absence of them in that region and by their distribution around it. In sections this area centralis is distinguishable by an increased thickness of the retina, and microscopically by the arrangement of the cells. The increased thickness is due to the greater length of the rods and cones, their close congregation together, and the larger number of cells in the nuclear and ganglion cell layers associated with them.

Chievitz (19) and Slonaker (20) have examined the eyes of a number of different species of mammals anatomically, and the latter has published their combined findings in tabular form. In some animals, such as rats and bats, no central area is discoverable. In rabbits, most of the Ungulates and the fox, there is a horizontal band-like area, which in the horse measures 5 to 7 mm. in breadth. Cats and some other Carnivora have a rounded central area. Krause (21) stated that cats possessed a fovea, but this was not found to be the case by Ganser (22) and Chievitz (19). Lindsay Johnson (3) sums up the correlation between the area centralis, the position of the eyes in the head and the shape of the cornea and lens as follows: "Sensitive areas of restricted dimensions, omitting those cases in which the area is limited to a macula, exist in the Carnivora, in which order the divergence is not great. In the Ungulates, Rodents, Edentates and Marsupials, where we find great divergence

of the axes, large corneæ and nearly spherical lenses, the sensitive areas are larger, and probably the degree of difference in perception over such areas compared with the more peripheral parts is but little."

Amongst Primates a fovea is met with in man, anthropoid apes and monkeys, but not in lemurs. It is found in some reptiles, and is present in practically all birds. In writing of these latter, Casey Wood (23) says: "The depth of the fovea may be regarded as a measure of the sharpness of vision. Slonaker classifies foveæ as deep, medium and shallow. The round fovea is specially 'deep' in swift fliers and birds of prey; 'medium' to 'weak' in most birds, except that it is 'shallow' in the domestic pigeon and probably lacking in the hen."

Anatomically the fovea consists in man of an area measuring about ·3 mm. in diameter, subtending an angle of about 70′, and lying almost exactly in the optic axis of the refractive media of the eye, at a point where the image projected by them is brought to the sharpest focus. It is characterised by an unfolding of the inner layers of the retina, which are spread apart so as to permit the direct unimpeded access of rays of light to the percipient end-organs of the retina. These end-organs consist exclusively of cones, and in the very centre of the fovea (Dimmers' foveola) of cones of a specially slender variety. Ramon y Cajal showed that each of the central cones is connected with but one bipolar cell and but one ganglion cell, thus differing from the end-organs in the more peripheral parts of the retina, each of which is connected with several bipolar and several ganglion cells.

The acuity of form-sense in man is most intense at the fovea and rapidly decreases on proceeding from it towards the periphery; thus it has been approximately estimated that 5° eccentric from the centre of the fovea the acuity is reduced to $\frac{1}{4}$ and 20° eccentric to $\frac{1}{40}$.

In the development of the human retina an area centralis is recognisable before the fovea centralis makes its appearance. According to von Hippel (24), in the

central area of the retina at birth all the layers are recognisable, though in the situation where the fovea ultimately forms, the cells of the ganglion cell-layer and of the inner nuclear layer are somewhat thin and spaced out. By the end of the fourth week a depression is formed, but the full development of the fovea is not completed until several months have elapsed. This gradual unfolding of the fovea corresponds with what has been observed regarding the development of an infant's power of fixation. Worth (25) has observed that the pupil contracts in a newborn infant if a light is suddenly flashed on to its eye in the dark, and that the child will try to fix it for an instant, as by a reflex act, showing that some preponderance in power at the macula is innate. He says: "At the end of two or four weeks most infants will fix a light steadily for several seconds at a time with one or other eye, but will not converge both visual axes accurately in looking at a near object. It is not until five or six weeks that binocular fixation manifests itself."

The high acuity of form-sense at the fovea may be due to—

(*a*) The close congregation of cones together in that region.

(*b*) The isolation of each cone in that region to one nerve-path.

(*c*) The opening out of the inner layers of the retina, allowing the unimpeded access of rays of light to the cones.

Probably all three factors are essential for clearness of definition in vision.

If, as suggested in the consideration of the light-sense, the response of the cones to light is a mechanical one, a contraction produced in one of them being capable of starting a stimulus in the isolated nerve-path with which it is connected, we have a very simple means of explaining the first stage in the production of the perception of form.

At the centre of the fovea in the human retina we have

an area in which 7000 cones are supposed to be crowded together ; 50 cones may be counted along a line of 200 μ in length ; the average diameter of each cone at its widest part is about 3 μ, and the distance between two adjoining cones 4 μ. Supposing now the image of a black letter on a white ground, such as we have in our test-types, to be focussed on this delicate mosaic of cones, those upon which the white background is projected will be stimulated and contract, those upon which the black letter fell, not being stimulated, will remain uncontracted. Indeed, it seems likely that if we could examine the outer surface of a retina so stimulated, under sufficient magnification, a reproduction of the letter looked at would be seen raised up and composed of the unretracted outer limbs of the cones.

An abnormally low acuity of central form-sense dating from birth, and unaccompanied by any obvious ophthalmoscopic changes, might be due to an absence of any one of the three above-mentioned characteristic features at the macula, so that the condition we describe as "congenital amblyopia" might be brought about in different ways ; we have, however, definite anatomical evidence that in connection with it the fovea is sometimes found to be absent.

Seefelder (26) recorded the absence of the fovea in a case of congenital amblyopia and nystagmus associated with aniridia. Its absence has also been noted in congenital amblyopia accompanying albinism. Further investigations as to the structure of the retina at the macula in connection with congenital amblyopia is, I suggest, much to be desired.

Monkeys, the class of mammals which first developed a fovea, like birds, in whom a fovea is almost always present, live an arboreal life. They, like birds, subsist on a diet of fruit and insects, which has to be picked up, picked off, or picked out. This picking process requires considerable concentration and sharpness of vision. In the case of birds it is done with the bill, and in the case of monkeys with the fingers.

Other mammals who have adopted the arboreal habit, such as lemurs, some of the Insectivora and rodents, have not developed a fovea, the reason probably being that they make more use of their teeth and comparatively elongated snouts for the picking up and preparation of their food than the higher Primates, and therefore require less acuteness of vision for detail.

The adoption by monkeys of feeding habits, intimately associated with the use of the hands and the formation of a central spot of acute form-sense, endowed them with the capacity of picking up objects and examining them closely. Such a capacity would tend to excite feelings of curiosity, the marked development of which is one of the characteristics of all apes, and from this would arise a desire for investigation. It must have been the overpowering influence of such a desire which induced man's ancestors to descend from the safety of the branches to explore the earth beneath, and thereby encounter new and unknown dangers. The appetite for exploration and research, thus started, grew by what it fed on, and continues to grow even up to the present time.

IV. Accommodation and Convergence.

Intimately associated with the evolution of the fovea centralis, and therefore with the adoption of aboreal life, is an increased capacity for accommodation and convergence.

The accommodative power of the eyes of mammals has been investigated by several different observers. All are agreed that its range is greatest in man, slightly less in apes, and very considerably less in all the lower orders.

Hess and Heine (27) found its range equal to 10–12 D. in apes; 2·5–3·5 D. in dogs; 1·25 D. in cats; 2·5–3 D. in a young wolf; and 0 in rabbits.

Barrett (28) was unable to detect any alteration of refraction, during examination by retinoscopy or with the ophthalmoscope, in any mammal except man and monkeys. Those which he examined were rabbits, guinea-pigs, rats,

mice, cows, horses and dogs among domestic animals; and deer, jackal, pecari, various cats, hyena, opossum, porcupine, mongoose and thirteen monkeys amongst wild animals. He found that electrical stimulation of the eyes of cats and dogs produced no result, and that the voluntary accommodation of monkeys was equal to 4 to 5 D.

Beer (29) estimated the range of accommodation in *Macacus rhesus* as equal to 10 D., and that in the anthro-

Fig. 5.

Ciliary body of the echidna.

poid and some other apes it was still greater, approaching even in the untailed apes to the degree present in man. By electrical stimulation of the freshly enucleated eye of the common cat he observed an increased projection of the anterior surface of the lens, but the increased refraction amounted only to 2 or 3 D. In the solipedes and ruminants he estimated the range as from $\frac{1}{2}$ to 2 D. In the hare and rabbit he totally failed to discover any change, either after administration of mioties or after electric stimulation.

Priestley Smith (30), by examining rabbits' eyes with the shadow test and the faradic current, convinced himself that there was some accommodative change, though in several it was slight and very transient.

In the horse and dog and probably in most wild mammals the refraction is hypermetropic, so that, their accommodation being feeble, their near point cannot be

Fig. 6.

Ciliary body of the great ant-eater.

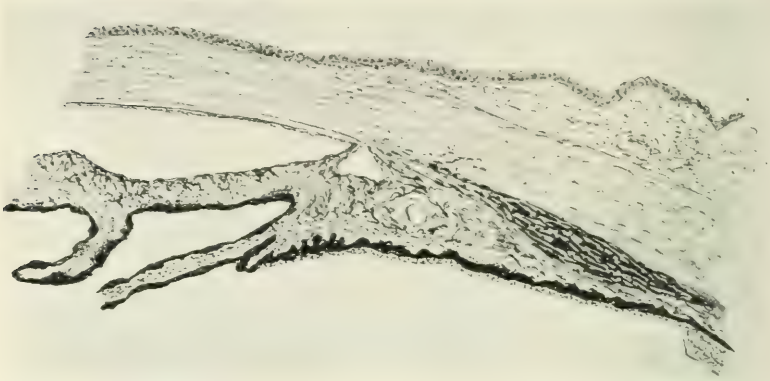
nearer than one or two metres away. Barrett thoroughly atropinised the eyes of a cat and then allowed it to pursue a mouse, which it caught without any difficulty.

I have examined microscopically sections of the ciliary body from the eyes of mammals belonging to various different natural orders, and find that the degree of development of the ciliary muscle corresponds fairly accurately with the degree of capacity for accommodation which the animal has been found to possess.

In some of the lowest mammals, such as the echidna

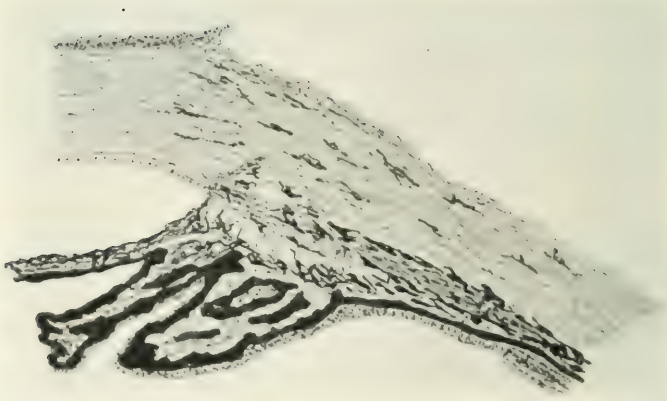
(Fig. 5) and the great ant-eater (Fig. 6), the ciliary muscle is practically non-existent. In rabbits (Fig. 7)

Fig. 7.



Ciliary body of the rabbit.

Fig. 8.

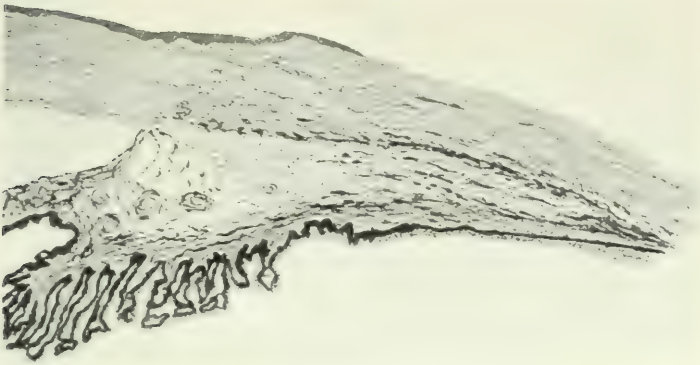


Ciliary body of the wallaby.

only a few scanty fibres are recognisable. In the marsupials (Fig. 8) there is a small definite bundle of

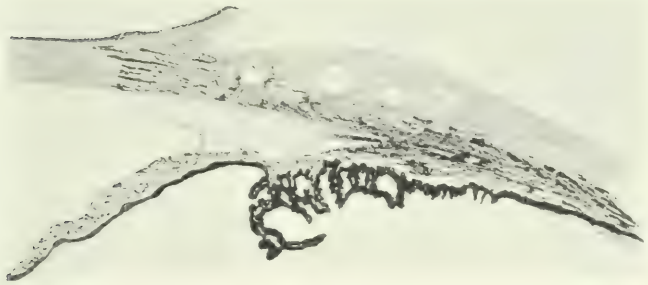
longitudinally placed fibres. In the Ungulata (Fig. 9) and Carnivora (Fig. 10) the longitudinally directed fibres are more numerous and form a considerably broader band.

Fig. 9.



Ciliary body of the ox.

Fig. 10.



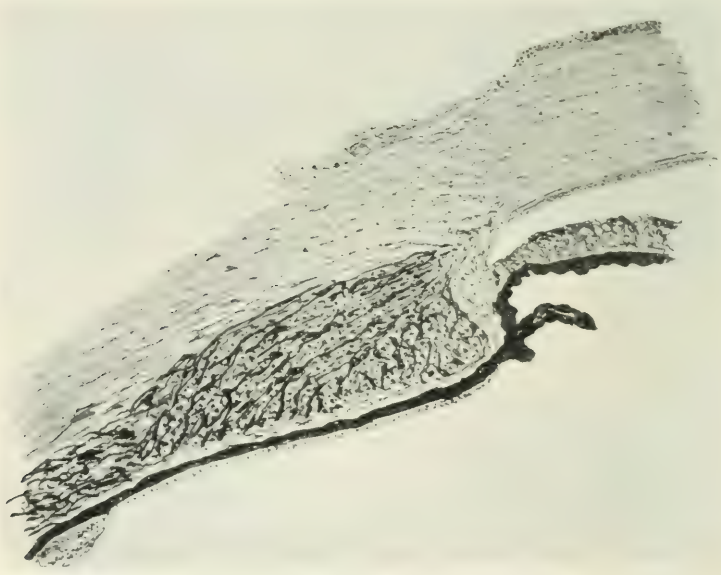
Ciliary body of the cat.

The ciliary muscle in apes (Figs. 11 and 12) and man shows an extensive increase in development on that met with in any of the other mammals. Not only is it wider and longer, but its fibres show a more complex arrangement. In all the other mammals which I have examined

it is composed entirely of longitudinal fibres; in apes and man it possesses also what have been described as radial and circular fibres (Fig. 13).

At the International Ophthalmological Congress held at Utrecht in 1899 I demonstrated how the arrangement of the ligamentum pectinatum also differs very consider-

Fig. 11.

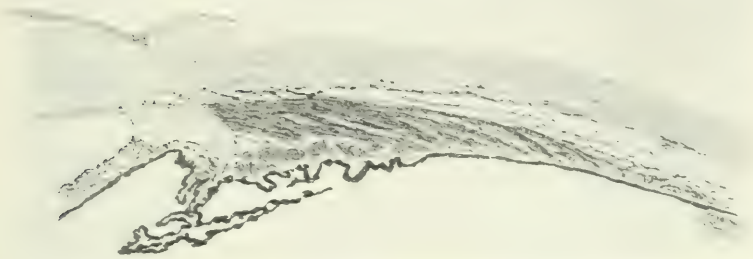


Ciliary body of the Rhesus monkey.

ably in man and apes from that met with in other mammals. In the human eye the fibres of which it is composed radiate out in a fan-like fashion from the position where Descemet's membrane ends, and the angle of the anterior chamber is prolonged outwards 0·8 mm. beyond that point. So that if a line vertical to the surface of the eye be drawn backwards through the canal of Schlemm it passes into the angle of the anterior chamber (Fig. 13). If the same line be continued

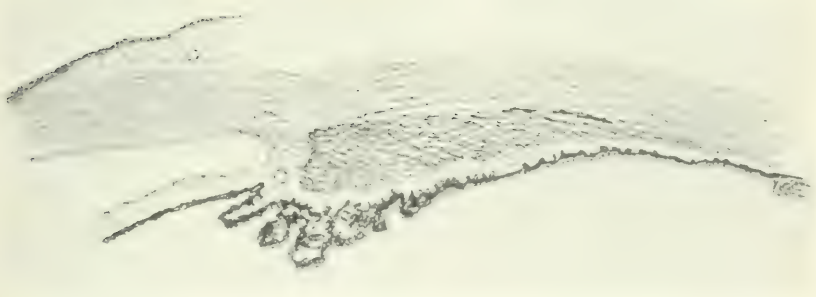
backwards it almost passes through the large circular artery at the base of the iris, and only a small portion of the ciliary processes lie to its inner side. In the lower mammals the ligamentum pectinatum is a much more

FIG. 12.



Ciliary body of a chimpanzee.

FIG. 13.



Ciliary body in the human eye.

extensive structure, filling up a large part of what forms the angle of the anterior chamber in the human eye. It is composed of an external laminated zone, attached on its outer surface to the sclerotic, which is wider and more spaced out than in the human eye, and an inner cavernous

zone with irregularly shaped spaces between its fibres (Fig. 9). The inner limit of the ligament, that facing the anterior chamber, in these animals, is bounded in places by what are called the pillars of the iris. These consist of prolongations forwards of the stroma of the iris to the back of the cornea, to which they are adherent just where Descemet's membrane terminates (Figs. 7 and 8). It is these bands of iris tissue, which are not present in man's eye, that give the toothed appearance to the ligament, and which led to its being compared to a comb. It is the disappearance of these pillars of the iris in man's eye which has allowed the anterior part of the ciliary body to become displaced backwards. As the angle of the anterior chamber in the lower mammals does not extend beyond the point where Descemet's membrane ends, a line drawn backwards vertically to the surface of the eyeball through the canal of Schlemm does not pass through the angle of the anterior chamber but some distance external to it, and the large circular artery of the iris, together with a large portion of the ciliary processes, lies to its inner side (Figs. 9 and 10).

The concentration of the fibres of the ligamentum pectinatum together in the human eye forms a fixed point, or tendon of origin, for the ciliary muscle. In the lower mammals, where the area occupied by the ligamentum pectinatum is broader and more spaced out, the fibres of the ciliary muscle do not have any fixed point of origin. Running longitudinally they terminate anteriorly in the spaces between the fibres of the ligamentum pectinatum, in the same way as they terminate posteriorly between the fibres of the lamina supra-choroidea (Fig. 10).

A comparison of the ciliary muscle in its different degrees of development in different mammals shows that the spindle-shaped cells of which it is composed lie between the fibres of the lamina supra-choroidea.

In the human eye the fibres of the lamina, if traced forwards, can be seen to enter the posterior border of the

ciliary muscle, so that the most anterior portion of the perichoroidal space is entirely free from any such fibres. If the uvea be separated from the sclerotic some of the anterior and external of the cells of the ciliary muscle may be found attached to the latter coat, being situated between the layers of what elsewhere forms the lamina fusca.

In some animals, as pointed out by Kalt, at the termination of the ciliary body posteriorly, in the spaces of the lamina supra-choroidea left empty by undeveloped muscle-fibres, a layer of large cells is met with continuous behind with the endothelial cells of the choroid.

In pathological specimens, where, as the result of œdema of the ciliary body, or as the result of traction from fibrous bands on its inner surface, its tissue has been much spaced out, I have met with large cells between the muscle-fibres, suggesting in their appearance transitional stages between endothelial cells and muscle cells.

Muscle-fibres, or at any rate cells which cannot be distinguished from them, are met with in isolated patches of the external surface of the choroid; thus Salzmann (31) writes: "If one follows the supra-choroidea from behind forwards new structural elements, smooth muscle-fibres, appear even in the equatorial region, or, at times, still further posterior, therefore in the territory of the choroidea. They are grouped in bundles singly, or for the most part branched, and then forming three or more rayed stellate little figures—'muscle stars.'"

Fuchs (32), in a recent article, has described how he found muscle-fibres in the lamina supra-choroidea in the neighbourhood of the papilla in frontal sections through the optic disc.

The above facts, taken together, all tend to show that the spindle-shaped cells composing the ciliary muscle are morphologically the same as the endothelial cells found in the spaces of the lamina supra-choroidea and in the pectinate ligament, and that the development of the

ciliary muscle is due to the proliferation and lengthening out of such endothelial cells.

Anatomists have frequently described Descemet's membrane as the uveal layer of the cornea, and I think such a description is both accurate and useful. Descemet's membrane is composed of the same elastic tissue as that of the pectinate ligament, both staining in a similar way with acid orcein. Elastic fibres are also found in the lamina supra-choroidea. The elastic tissue of Descemet's membrane has been proved to be produced as a kind of secretion of the endothelial cells lining it. In the human fœtus, before the iris is formed, and before there is any anterior chamber, two parallel rows of cells are seen lying interposed between the cornea and the anterior capsule of the lens. The anterior chamber is developed as a space between these two rows of cells, the anterior of which becomes the lining endothelium of Descemet's membrane, and the posterior the endothelium on the surface of the iris and of the pupillary membrane. It may therefore be claimed that not only does Descemet's membrane represent the uveal layer in the cornea, but that the anterior chamber is analogous to an opened-out and enlarged potential space of the lamina supra-choroidea.

These morphological analogies of the fibres of the ciliary muscle and its surroundings are of considerable assistance in understanding the distribution of its fibres in the human eye. Having recognised that the fibres of which the muscle is composed are developed from cells contained in spaces on the outer surface of the ciliary body, it becomes evident that the shape and direction of these muscle-fibres will depend on that of the spaces in which they are formed.

In all mammals in which the ciliary muscle is rudimentary its fibres run longitudinally (Figs. 7, 8, 9 and 10). It is only when we come to the more highly developed ciliary muscle of Primates that we meet with the addition of radial and circular fibres internal to the longitudinal

ones (Figs. 11, 12 and 13). It is in these animals also that we meet with a considerable displacement backwards of the anterior part of the ciliary body, due to disappearance of the pillars of the iris, and alteration in the arrangement of the fibres of the pectinatum already referred to. The ciliary processes in Primates, instead of projecting out from the back of the iris, have become displaced outwards and backwards beyond its root, thus altering the shape and direction of the lymph-spaces immediately external to them. The innermost of these spaces assume a circular direction, and those more external a radial course; the muscle-fibres developing in these spaces from the cells lining them take the same direction.

Donders (33) pointed out that the construction of the ciliary muscle varies with the refractive condition of the eye. He found that in actual myopia it was flatter and longer than in emmetropia or hypermetropia, and that its point of origin from the fibres of the ligamentum pectinatum was situated further back.

Iwanoff (34) described how, in myopia, the ciliary muscle consists almost entirely of longitudinal fibres, "Brücke's muscle," the circular fibres, "Müller's muscle," being absent, whilst in hypermetropia he found that the circular fibres were more numerous than in emmetropia, and formed a considerable inward projection from the anterior part of the muscle. This inward projection of the muscle is accompanied by an inward projection of the ciliary processes behind the root of the iris. In myopia the ciliary processes are much less prominent, and are separated by a considerable distance from the root of the iris.

No doubt, as has frequently been pointed out, the ciliary muscle in hypermetropia, having more work to do, is hypertrophied, whilst in myopia, having but little work to do, it is atrophic. I think, however, the direction of its fibres is largely influenced by the length of the antero-posterior axis of the eyeball. Where this has

been abnormally increased, as in axial myopia, the uveal tissue is considerably stretched, the ciliary processes are drawn backwards, and the spaces in the tissue immediately external to them are also drawn backwards and elongated out. The fibres of the ciliary muscle contained in these spaces become likewise altered in their direction, and assume a longitudinal position antero-posteriorly instead of running circularly.

In hypermetropia, where the eyeball is abnormally short from before backwards and not fully developed, the ciliary processes, as in the embryonic condition, and as in the lower animals, project further forwards and inwards, so that the spaces external to them, and the muscle-fibres contained therein, have a circular direction.

In animals below Primates in which the ciliary muscle has scarcely any more fixed point of attachment anteriorly than it has posteriorly, and where its fibres have all a longitudinal direction, the effect of their contraction would appear to produce a drawing together, or rucking up, of the inner surface of the ciliary body, much in the same way as contraction of the dilator muscle-fibres of the iris draws together or rucks up the iris in dilation of the pupil (Fig. 10). In apes and in man the concentration together of the fibres of the pectinate ligament at the sclero-corneal margin produces a sort of tendon, or fixed point of origin, to the ciliary muscle. So that on its contraction the tissue into which it is inserted is drawn forwards towards this fixed point.

A study of the morphology and embryology of the lens and its suspensory ligament seems to leave no doubt that the effect of contraction of the ciliary muscle is, as Helmholtz pointed out, a slacking of the suspensory ligament and a relaxation of tension in the lens fibres.

The following table gives the measurements of the antero-posterior and lateral diameters of the lens in the eyes of several different mammals:

Diameters of the Lens in Mammals.

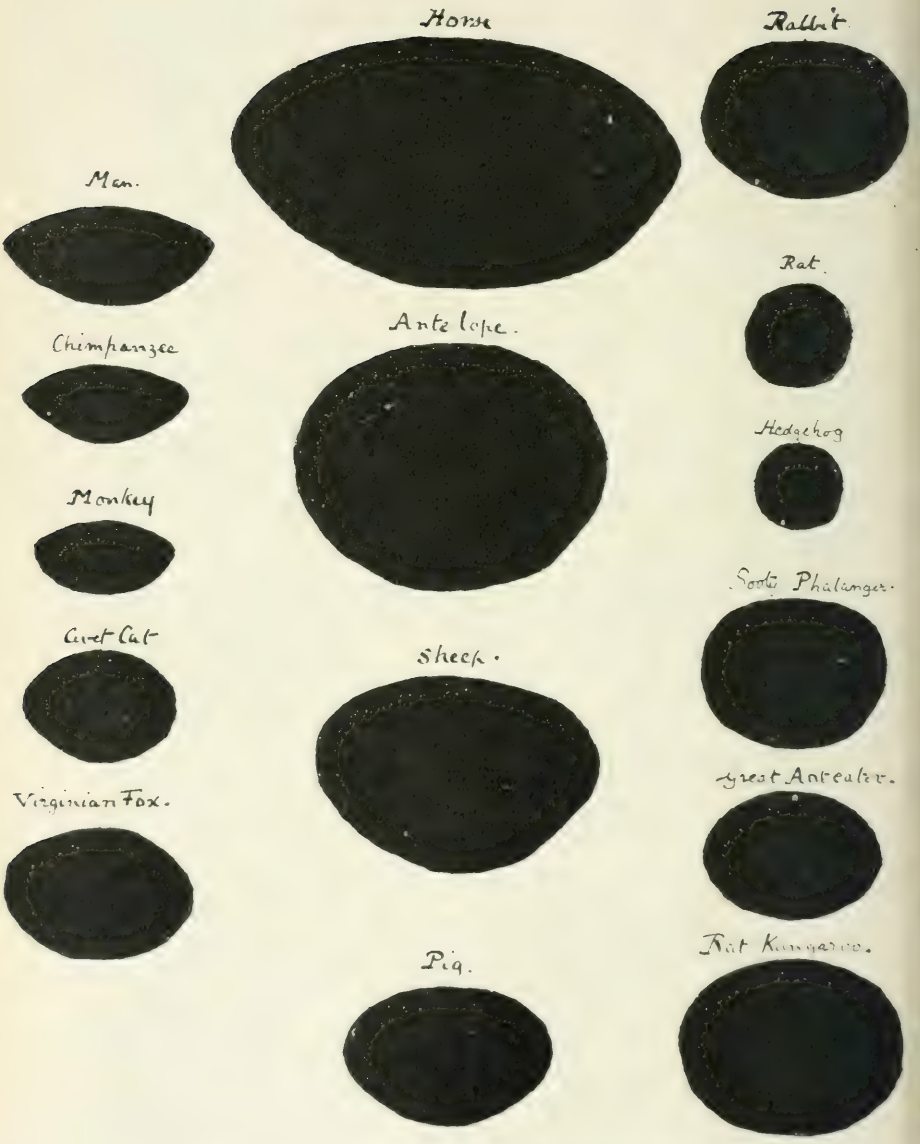
	Antero-posterior.	Lateral.
Man	4·5 mm.	9 mm.
Chimpanzee	4 ,,	7 ,,
Monkey	3·5 ,,	6 ,,
Civet cat	5 ,,	6·5 ,,
Virginian fox	6 ,,	8 ,,
Horse	11 ,,	20 ,,
Antelope	11 ,,	14 ,,
Sheep	10 ,,	12·5 ,,
Pig	6 ,,	9 ,,
Rabbit	7 ,,	9 ,,
Rat	4 ,,	4·5 ,,
Hedgehog	3·5 ,,	3·5 ,,
Sooty phalanger	7 ,,	9·5 ,,
Great ant-eater	6 ,,	8 ,,
Rat kangaroo	8 ,,	10 ,,

From this it will be seen that in man the antero-posterior diameter of the lens measures nearly half that of the lateral diameter. In monkeys it is a little more than half, whilst in all the other mammals the proportional difference between the two diameters is considerably less, and in some of them the lens is almost spherical (Fig. 14).

In man and monkeys the ciliary processes are separated from the sides of the lens by a definite space—the so-called circumlental space. In all other mammals the ciliary processes lie in contact with the sides of the lens.

It seems natural to infer that the flattening of the lens from before backwards in man's eye has resulted from the growth of the ciliary body away from the sides of the lens, and the traction which is thereby produced on its anterior and posterior capsule through the suspensory ligament. An examination of embryonic human eyes in different stages of development confirms this view. The ciliary processes, when first formed, are in contact with the sides of the lens, and with the growth

FIG. 14.



Lenses in mammals drawn three times natural size.

of the eyeball gradually become separated from it. In association with the gradual separation of the two structures there is alteration in the shape of the lens from that of a sphere to that which it assumes in the fully formed eye.

The following table gives the measurements of the antero-posterior and lateral diameters of the lens in a series of human fœtal eyes of different ages, and those recorded by Dub [35] from the ninth month to the twelfth year:

Age.	Antero-posterior.	Lateral.
Fourth month	2·8 mm.	3·3 mm.
Fifth ,,	3·5 ,,	4 ,,
Sixth ,,	3·8 ,,	4·5 ,,
Seventh ,,	4 ,,	5 ,,
Ninth ,,	4·3 ,,	5·75 ,,

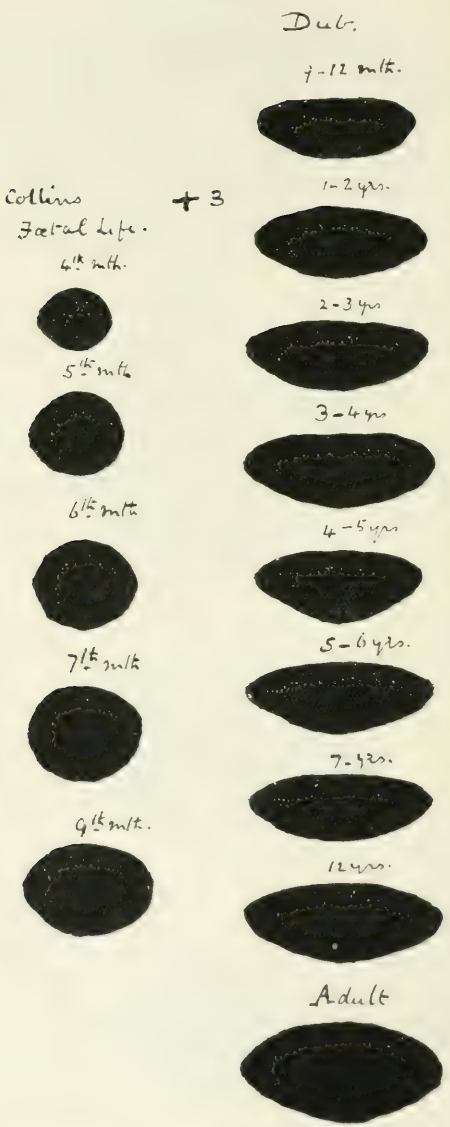
To these may be added those given by Dub from the ninth month to the twelfth year.

Age.	Antero-posterior.	Lateral.
9–12 months	2·46 mm.	7·46 mm.
1–2 years	2·57 ,,	7·87 ,,
2–3 ,,	2·72 ,,	8·2 ,,
3–4 ,,	2·83 ,,	8·46 ,,
4–5 ,,	3·0 ,,	7·8 ,,
5–6 ,,	3·2 ,,	8·4 ,,
7 ,,	2·9 ,,	8·2 ,,
12 ,,	3·6 ,,	8·8 ,,
Adult	4·5 ,,	9 ,,

From this it will be seen that the lens, when first formed, is spherical in shape, and gradually assumes its flattened condition with the growth of the eyeball. After birth the traction on the sides of the lens causes a diminution in its antero-posterior diameter (Fig. 15).

If further confirmation is required that flattening of the lens and consequent bowing of its fibres occurs, as the result of traction on its sides, it is to be found in the effects of pathological enlargement of the eye-

Fig. 15.



Lenses in human eyes at different ages, drawn three times natural size.

ball, such as occurs in cases of congenital glaucoma—so-called buphthalmos. In this disease there is considerable expansion of all the diameters of the eyeball, and considerable widening of the ciliary region, so that the ciliary processes become separated further than normally from the sides of the lens, and the circumlental space is increased in width. At the same time the antero-posterior diameter of the lens is diminished and the lateral diameter increased. In one specimen which I have the antero-posterior diameter of the lens measures 3·5 mm., the lateral 9 mm., and in another the antero-posterior diameter is 4 mm. whilst the lateral is 10 mm.

Investigations into the anatomy of the suspensory ligament of the lens have shown that it is composed of separate bundles of fibres, which run in different directions, and to which specific names have been attached. The two chief bundles are: the orbiculo-antero-capsular fibres, lying in the valleys between the ciliary processes, which attach the posterior non-plicated part of the ciliary body to the anterior capsule of the lens; and the cilio-postero-capsular fibres, passing between the bundles of orbiculo-antero-capsular fibres, which attach the anterior part of the ciliary processes to the posterior capsule of the lens. A third set of fibres—the equatorial—attaches the centre of the ciliary body to the side of the lens capsule.

To understand how these different bundles of fibres of the suspensory ligament are developed, it is necessary to examine the relations which the ciliary body, or the part of the eye which ultimately becomes the ciliary body, bears to the side of the lens at different periods of fœtal life. For some time the two structures lie in contact, and it is while they are in contact that adhesions form between them, which ultimately develop into the fibres of the suspensory ligament. At an early stage of fœtal life, before the iris and ciliary processes have commenced to form, the part of the globe where the non-plicated part of the ciliary body ultimately develops lies in contact with the anterior capsule of the lens, and forms adhesions

to it. On the growth of the globe this part of the ciliary body gradually recedes, the ciliary processes budding out in front of it. The direction in which the ciliary processes grow is at first inwards and backwards, so that they come to lie in contact with the posterior capsule of the lens, and whilst there form adhesions to it. On the expansion of the globe the ciliary processes become separated from the sides of the lens—a separation which is still further increased on the formation of the anterior chamber, which displaces the lens backwards. The growth of the ciliary body away from the side of the lens causes the adhesions which have formed between them to be lengthened out into the fibres of the suspensory ligament. It also, by exerting traction on the anterior and posterior capsule, and sides of the lens, causes that structure to alter its shape, so that it loses its spherical form and becomes flattened antero-posteriorly; the flattening is more marked on the anterior surface than the posterior because the traction is greater on the anterior capsule than the posterior, due to there being a wider separation of the non-plicated part of the ciliary body from the anterior capsule of the lens, than of the ciliary processes from the posterior capsule. Flattening of the lens antero-posteriorly, due to traction on its anterior and posterior surfaces, increases the curve of its fibres, and keeps them so curved until the traction on the two surfaces is relaxed, *i. e.* until the suspensory is rendered slack by the contraction of the ciliary muscle. The effect of such slackening must necessarily be most on the anterior surface upon which the traction is greatest, and most of all in the central circular area on the anterior surface around which the most anterior of the fibres of the suspensory ligament are attached.

The further the backward growth of the non-plicated part of the ciliary body, with the orbiculo-antero-capsular fibres attached to it, the greater will be the traction on the anterior capsule of the lens and the increase of latent accommodative power. One of the features in the archi-

tecture of the eye in man and monkeys, which is strikingly distinctive from that in lower mammals, is the elongation of the pars plana of the ciliary body, *i. e.* the region situated between the hindermost of the ciliary processes and the ora serrata. This is brought out to some extent in the following table, which shows in a series of mammals' eyes the length of a straight line drawn between the root of the iris and the ora serrata in one column, and the antero-posterior diameter of the eyeball in the other :

	Antero-posterior diameter of eyeball. mm.	Distance between root of iris and ora serrata. mm.
Man	24·8	6
Chimpanzee	19	4·25
Rhesus monkey	19·5	5
Capuchin monkey	18·5	4·25
Cat	22	3·5
Horse	44	5 to 10
Ox	35	6·5
Antelope	27	3 to 5
Sheep	28	3 to 6
Pig	22	4
Rabbit	19	2

In the Ungulata two measurements are given, because in animals with horizontal oval pupils the distance of the root of the iris from the ora serrata is considerably less where the iris is narrow than where it is broad.

From this table it will be seen that in man and monkeys the distance between the root of the iris and the ora serrata is about one-quarter of the antero-posterior diameter of the globe, whilst in all other mammals, except the Ungulata, it is considerably less. In the Ungulata, whilst it measures nearly one-fourth in the vertical diameter, it is considerably less in the lateral.

A lens flattened antero-posteriorly has considerably less

refractive power than a spherical or nearly spherical one. The lesser refractive power of the lens in man and monkeys, due to flattening of it antero-posteriorly, is to some extent compensated for, as already mentioned, by increased refractive power in the cornea. Further compensation is effected by increase in the depth of the vitreous chamber and displacement backwards of the retina, on which the image of the object looked at has to be focussed. The following table gives the depth of the vitreous chamber from the posterior pole of the lens directly backwards to the retina, and the diameters of the lens, in a series of mammalian eyes. From this it will be seen that a decrease in the sphericity of the latter is accompanied by an increase in the depth of the former.

		Lens.	
	Vitreous chamber.	Antero-posterior.	Lateral.
Man	15·4 mm.	4·5 mm.	9 mm.
Chimpanzee	11·5 ,,	4 ,,	7 ,,
Horse	20 ,,	11 ,,	20 ,,
Antelope	12 ,,	14 ,,	17·5 ,,
Pig	9 ,,	6 ,,	9 ,,
Rabbit	6 ,,	7 ,,	9 ,,

Thus, whilst in the rabbit and antelope the depth of the vitreous chamber is less than the width of the antero-posterior diameter of the lens, in the horse and pig it is considerably greater. In man and the chimpanzee the depth of the vitreous chamber is nearly three times as great as the width of the antero-posterior diameter of the lens.

A similar comparison may be made in the changes which take place in the shape of the lens and in the depth of the vitreous chamber during the process of development of the human eye. The following table shows the depth of the vitreous chamber and the diameters of the lens of the developing human eye up to the time of birth.

Age.	Vitreous chamber.	Lens. Antero-posterior.	Lens. Lateral.
Fourth month	4·5 mm.	2·8 mm.	3·3 mm.
Sixth month	5 ,,	3·8 ,,	4 ,,
Seventh month	7·5 ,,	4 ,,	4·5 ,,
Ninth month	9·5 ,,	4·3 ,,	5·75 ,,
At birth	11 ,,	3·75 ,,	7 ,,

Weiss (36) has shown that the anterior segment of the eyeball grows rapidly during the first year of life and attains its full dimensions by the end of the second year. The subsequent growth of the eye, which continues into the twenties, is entirely due to an expansion of the posterior segment. At birth the depth of the vitreous is 11 mm. and in the adult eye 15·4 mm.

This difference in the depth of the vitreous chamber in different classes of mammals, and at different periods in the course of development in man's eye, may be correlated with the varying states of refraction met with.

The refraction of the eyes of a large number of mammals has been investigated by Lang and Barrett (37) and by Lindsay Johnson (3). Their investigations agree in showing that wild species of mammals are always hypermetropic. Lindsay Johnson says: "A slight degree of hypermetropia, *i. e.* under one dioptre, may be said to be the rule throughout the higher mammals, whilst higher hypermetropia, *i. e.* 2 D. to 5 D., is found in the wild species of rodents, the Edentata and the marsupials."

Amongst domesticated mammals myopia is not uncommonly met with. In a series of mammals Lang and Barrett found it in the following proportions of the eyes examined: Rabbits, 5 out of 52; guinea-pigs, 5 out of 28; rats, no myopia, but 1 mixed astigmatism out of 10; cows, no myopia in 10; horses, no myopia, but 1 mixed astigmatism out of 6; cats, 2 out of 14; dogs, 2 slight myopia out of 6. Lindsay Johnson says: "Myopia is frequently met with both with and without astigmatism among domesticated animals, especially guinea-pigs, rabbits and other rodents kept in confinement in small hutches."

He also states that he found myopia to be a persistent characteristic in mandrils and baboons. Lang and Barrett found that 2 monkeys out of 11 which they examined were myopic. There is no note as to how long these myopic monkeys had been kept in confinement previous to having their refraction tested.

The tendency to the development of myopia as an outcome of confinement in restricted spaces seems to be an example of adaptation of structure to function, *i. e.* an elongation of the posterior part of the eyeball to meet requirements of vision for near objects. It is similar to the condition of things which is met with in human beings. The incompletely developed eye of the newborn is nearly always hypermetropic, the mean amount met with having been estimated by different observers as 2·3 D. and 3 D. During the first decade of life the hypermetropia curve rapidly falls, whilst the percentage of myopes increases during the first two decades.

Man's eyes at birth are comparable to those of terrestrial mammals in the natural state, who have not adopted arboreal life. His lenses are then nearly spherical and his vitreous chambers of comparatively little depth, so that his eyes are adapted for vision at long distances, with but little capacity for the focussing of near objects. By expansion of the globes, flattening of the lenses antero-posteriorly and increase in the depth of the vitreous chambers, man's eyes gradually reach that condition which is most suitable for his environment under normal conditions, *i. e.* where parallel rays are brought accurately to a focus on the macula when the ciliary muscle is at rest, and where there is an ample capacity of accommodation for near objects. If, whilst this developmental process, which lasts up to the twentieth year, is still proceeding, man's vision becomes unduly restricted to use at short ranges, then, as in the lower mammals which are kept confined in small compartments, adaptation of structure to function tends to take place, the vitreous chambers become deeper than normal and myopia is developed.

As already pointed out, the development of a highly acute spot of central vision for form-sense is correlated in mammals with a change in feeding habits, viz. the use of the hands for picking up food and conveying it to the mouth, instead of in the first place seizing it with the mouth. When the food consists of small things, such as fruits, grains, nuts and insects, acute form-sense, unless accompanied by active accommodative power, would be of very limited use. Hence, like the development of the fovea centralis, the increased range of accommodation, which has necessitated the extensive changes in the shape and structure of the eye just mentioned, has been the outcome of the adoption of arboreal life.

Just as we find the development of active accommodation linked up with the development of acute central form-sense, so we find the power of convergence linked up in its formation with the development of active accommodation. Indeed these three visual factors appear to have evolved, *pari passu*, with life in the trees.

As has already been pointed out, the evolution of conjugate movements of the eyes is associated with the presence of semi-decussation of the fibres of the optic nerves at the chiasma, the receipt of visual impressions from the two eyes on the same side of the brain, and the development of corresponding points in the retina. These conjugate movements reach to a high degree of perfection in the Carnivora, but it is only when we come to the Primates that we meet with a highly developed power of convergence in association with stereoscopic vision.

Some reptiles and birds are able to converge the axes of the two eyes on objects when feeding, but they have complete decussation of the fibres of the two optic nerves. Visual impressions from the two eyes are not received in them on the same side of the brain, so that they do not have true stereoscopic vision. A movement of the eyes may be observed in some of the Ungulata, when their attention is suddenly attracted, which is an approach

towards convergence, but which is really more a movement from divergence towards parallelism. It is exceedingly well depicted in a plate in Chalmers Mitchell's book on *The Childhood of Animals*, which shows a group of spring-bok facing the artist, in the characteristic attitude of attention, at the London Zoological Gardens a few hours after a kid was born. In the Carnivora more obvious attempts at convergence may be noted; when holding food with their front paws they tear it with their teeth. Dogs can be trained to converge by having a lump of sugar placed on their nose "on trust."

The associated evolution of acute central form-sense, accommodation and convergence, is of considerable interest when we consider the intimate dependence of each one upon the others for purposes of stereoscopic vision. If any one of these three faculties becomes seriously interfered with, so that the balance between them is disturbed, then the recently acquired capacity of fusing the images seen with the two eyes is given up, and one eye only is employed for fixation, the other being allowed to wander in the direction of least resistance, the condition we speak of as concomitant strabismus being established. Concomitant strabismus may be the outcome of several different causes, but three well-established predisposing factors are: (1) A defect in the development of the central form-sense in one eye, *i. e.* congenital amblyopia: (2) the presence of hypermetropia, which leads to an excessive amount of accommodative effort being made in the focussing of the images of near objects; (3) the presence of heterophoria, which leads to undue amount of effort on the part of the recti muscles to maintain the requisite amount of convergence.

V. Colour-Sense.

The colour-sense of mammals has been investigated by experiments and by a study of their natural history. I propose briefly to summarise the conclusions these investigations have led to, discuss the way in which the

colour-sense has been influenced by the adoption of arboreal life, and endeavour to correlate its varying degrees of acuteness with the different anatomical appearances met with in the percipient end-organs of the retina.

Many carefully thought-out experiments have been performed to test the chromatic sense in mammals, and in some elaborate precautions have been taken to exclude any fallacy which might be occasioned by unequal degrees of luminosity. These experiments have mostly been applied to dogs and monkeys. The details of them will be found well epitomised in Parsons' (17) book on *Colour Vision*. It will suffice for my purpose here to quote only the results obtained.

Graber (38) found that the pig and the dog could distinguish between blue and red, showing a distinct preference for the former; it is, however, doubtful if this preference was not due to brightness rather than colour.

Kalischer (39) came to the conclusion, from feeding experiments he carried out on dogs, that there is no doubt of their ability to perceive differences of hue as well as differences of brightness; but that there exist considerable differences in their sensibility to colour.

Miss E. M. Smith (40), from an elaborate series of experiments on dogs, summed up her conclusions as follows:

"(1) That while evidence has been obtained to show that some dogs possess a rudimentary power of colour discrimination, such discrimination is highly unstable and cannot be supposed to play any part in the animals' normal existence.

"(2) That the colour-sense is, as shown by the high colour threshold, very weak.

"(3) That colour discrimination, even where clearly established, may be readily inhibited by differences of luminosity or position."

Kinnaman (41) carried out experiments on monkeys with food in glass tumblers covered with different

coloured cards, and came to the conclusion that their capacity to distinguish colour as such was undoubted.

Dahl (42) coloured some sweets and some bitter substance with different coloured dyes; he found that after a few attempts a monkey learned to leave without even tasting those which were coloured with the dye indicating a bitter substance, and to seize at once upon those coloured to indicate sweets. Varying the experiments sufficiently he found that the monkey distinguished all the different colours readily except dark blue.

Hess (43) tested a monkey in the following manner: Grain was scattered over a black surface upon part of which a spectrum was thrown. The monkey gathered all the grains from the extreme red to the extreme violet, leaving those unilluminated. When the animal was dark-adapted and the intensity of the light diminished until the grains were visible to the dark-adapted experimenter only in the yellow and green, only those grains were gathered. Hess concludes that the extent of the spectrum is the same for the monkey as for man, and that it is brightest for the dark-adapted monkey in the region where it is also brightest for the dark-adapted man.

From the results obtained by these various experimenters it seems evident that the colour-sense of monkeys is much the same as in man, but that that of dogs and of other mammals experimented on is much less highly developed.

The origin of the colour-sense and of the colouring of animals received much attention from the great pioneers of evolution of the last century—Darwin, Alfred Russell Wallace, Lubbock and Grant Allen. Much of what they wrote brings out very clearly what I am now endeavouring to show, viz. that the colour vision of Primates is far more acute than that of other mammals, and that this is due to their arboreal life with its natural accompaniment of a frugiferous diet. I cannot do better than quote from their writings, especially from Grant Allen's (44) fascinating book on *The Colour Sense: its Origin and Development*, which has not, I think, attracted the

amount of attention which it deserves. What is to be learnt regarding the colour-vision of mammals from a study of their natural history he sums up as follows:

"When we come to the highest class of vertebrates—the Mammalia—strangely enough the evidence of a colour-sense almost fails us. The antipathy of male ruminants for scarlet and the curiosity which certain monkeys display with regard to bright-coloured objects are the only facts in point which come under ordinary observation. This result, so contrary to what we might have expected, appears quite natural when we examine more closely the circumstances of the case. By far the larger part of the mammals are herbivorous like the ruminants and pachyderms, or carnivorous like the technical carnivores, insectivores and whales. Only a small portion of the class subsists upon fruits, while none of them are very specially connected with flowers. Hence a large set of possible tests which we can employ in the case of insects and birds are wholly inapplicable to mammals. Moreover, the want of close relations with the coloured parts of plants has probably resulted in a want of any peculiar love for bright colour, such as we see reason to suspect in the butterflies, humming-birds and parrots. This absence of taste for brilliancy is probably marked by the absence of brilliant hues in the animals themselves; the result of sexual selection for these hues, as we shall see hereafter, only appears among the Mammalia in a few higher arboreal and frugivorous species, such as the mandril and certain squirrels."

Alfred Russell Wallace (45), in discussing the origin of the colour-sense, said: "The primary necessity which led to the development of the sense of colour was probably the need of distinguishing objects much alike in form and size but differing in important properties, such as ripe and unripe or eatable and poisonous fruits, flowers with honey or without, the sexes of the same or of closely allied species. In most cases the strongest contrast would be the most useful, especially as the colours of the

objects to be distinguished would form but minute spots or points when compared with the broad masses of tint of sky, earth or foliage against which they would be set."

The association of brilliant hues in the external coverings of animals with those of the objects from which they obtain their food is very striking. Humming-birds, which are the most highly coloured of all birds, obtain their food from flowers; they have a bifid tubular tongue which they insert into the corolla of flowers to suck up the honey. Parrots, whose plumage is generally extremely bright and gaudy, live for the most part on brightly coloured fruits. The colouring of rapacious and carrion birds, on the other hand, is always dull and destitute of any decorative hues.

With regard to colours in the external coverings of mammals, Grant Allen (44) says: "The whole series, whether among marsupials, pachyderms, Cetacea, ruminants, Carnivora or Insectivora, show almost uniform tints of black, brown, grey or dingy yellow. It is true that many animals, like the zebras, tigers, spotted deer and giraffes, have very noticeable alterations of light and dark shades, but they do not yield us pure spots of green, blue, red or yellow. When we come to the essentially arboreal mammals, however, the tree rodents and the Quadrumana, we get many comparatively brilliant species. The squirrels are often remarkable for their beautiful colours, and the so-called flying squirrels call for special notice in this respect."

Darwin (46), in his *Descent of Man*, described the various decorative colourings met with in monkeys. He said: "In very many species the beard, whiskers and crests of hair round the face are of a different colour from the rest of the head, and when different are always of a lighter tint, being often pure white, sometimes bright yellow or reddish. The whole face of the South American *Brachyurus calvus* is of a 'glowing scarlet hue'; but this colour does not appear until the animal is nearly mature. The naked skin of the face differs wonderfully

in colour in the various species. It is often brown or flesh-colour, with parts perfectly white, and often as black as that of the most sooty negro. In the *Brachyurus* the scarlet tint is brighter than that of the most blushing Caucasian damsel. It is sometimes more distinctly orange than in any Mongolian, and in several species it is blue, passing into violet or grey. In all the species known to Mr. Bartlett, in which the adults of both sexes have strongly-coloured faces, the colours are dull or absent during early youth. This likewise holds good with the mandril and rhesus, in which the face and the posterior parts of the body are brilliantly coloured in one sex only."

There is no member of the whole class of mammals which shows such resplendent colours as the adult male mandril; they have been compared with those of the most brilliant birds. The following is the description of one of these animals now in the Zoological Society's Gardens. The rather long, harsh hair is dark over the body, but each separate hair is ringed with black and yellow towards the tip, the pattern in certain lights giving a greenish tinge to the fur similar to the shade of other baboons and many other African monkeys. On the forehead there is a crest of hair and on the chin a yellow beard. The naked patches on the buttocks are bright red in the adults. On each side of the face, reaching from the eyes to the nostrils, is a corrugated swelling, divided into a number of longitudinal ridges. These ridges are bright blue and furrows between them purple. The muzzle, of a bright scarlet, is surrounded by a raised border like that of a pig.

At first it seems strange that the buttocks should be the part of the body which in some monkeys has acquired the most highly decorative colour. In a supplemental note "on sexual selection in relation to monkeys" at the conclusion of his book on *The Descent of Man*, Darwin brings together evidence to show that monkeys so ornamented are proud of their bright red rumps; they turn and display them to old friends and new acquaintances as

a form of greeting. These naked parts become more turgid and of a brighter colour during the season of love; their display before the female probably acts as a sexual excitement and their proximity to the sexual organs may in this way be explained.

From the foregoing it will be seen that in mammals as in birds there is a very close correlation between the character of their food and their external colouring. It is only those who have adopted a frugivorous diet that have acquired brilliant hues. How important a good sense of colour must be to a fruit-eating animal became clearly demonstrated to me while I was on a visit to Norway; the wild strawberries were then ripe, and several of my party began to gather them; one man, however, could not find any, and it was afterwards discovered that he was red-green blind. Had he had to depend for his sustenance on such small fruits, which he gathered for himself, he must soon have perished.

In both birds and mammals bright colouring is often sex-limited, and most frequently it is the male which is the more resplendent. Physiologists are generally agreed that such secondary sexual characters are dependent on internal secretions of the genital organs—testes or ovaries. This point lends considerable support to the Darwinian hypothesis of sexual selection. It is an hypothesis which, if accepted, recognises the presence of the colour-sense in those animals who have acquired sex-limited decorative hues. The theory of sexual selection raised so much controversial discussion that it will be well here to quote what such an authority as Prof. Weissman (47) wrote concerning it fifty years after the publication of *The Origin of Species*: "I really see no reason why we should doubt the power of sexual selection, and I myself stand wholly on Darwin's side. Even though we certainly cannot assume that the females exercise a conscious choice of the handsomest mate and deliberate like the judges in a court of justice over the perfections of their wooers, we have no reason to doubt that distinctive forms (decorative

feathers) and colours have a particularly exciting effect upon the female, just as certain odours have among animals of so many different groups, including the butterflies. The doubts which existed for a considerable time, as a result of fallacious experiments, as to whether the colours of flowers really had any influence in attracting butterflies, have now been set at rest through a series of more careful investigations. We now know that the colours of flowers are there on account of butterflies, as Sprengel first showed, and that the blossoms of phanerogams are selected in relation to them, as Darwin pointed out. Certainly it is not possible to bring forward any convincing proof of the origin of decorative colours through sexual selection, but there are many weighty arguments in favour of it, and therefore a body of presumptive evidence so strong that it almost amounts to certainty."

At the conclusion of his book Grant Allen (44) summarises the whole evolution of colour-sense in the following glowing passage: "Insects produce flowers. Flowers produce the colour-sense in insects. The colour-sense produces a taste for colour. The taste for colour produces butterflies and brilliant beetles. Birds and mammals produce fruits. Fruits produce a taste for colour in birds and mammals. The taste for colour produces the external hues of humming-birds, parrots and monkeys. Man's frugivorous ancestry produces in him a similar taste, and that taste produces the various final results of human chromatic art.

"What a splendid and a noble prospect for humanity in its future evolution may we not find in this thought, that from the coarse animal pleasure of beholding food, mankind has already developed through delicate gradations our modern disinterested love for the glories of sunset and the melting shades of ocean, for the gorgeous pageantry of summer flowers, and the dying beauty of autumn leaves, for the exquisite harmony which reposes on the canvas of Titian, and the golden haze which

glimmers over the dreamy visions of Turner! If man, base as he yet is, can nevertheless rise to-day in his highest moments so far above his sensuous self, what may he not hope to achieve hereafter, under the hallowing influence of those chaster and purer aspirations which are welling up within him even now towards the perfect day!"

It would be interesting to be able to correlate with these views on the evolution of colour-sense definite changes in the structure of the retina. Such knowledge as we at present possess permits of this being done in only a tentative manner. The colour-sense in man, like the form-sense, is most acute at the macula, where cones only are present. Though the final appreciation of both form and colour is evidently a psychological process, it seems to be an essential preliminary step in such appreciation for some change to take place in the end-organs of the nerve-fibres in the retina. That the change which gives rise to the sensation of form is essentially different from that which gives rise to the sensation of colour is shown by the fact that the one may be deficient without the other being impaired. In cases of congenital amblyopia the form-sense is defective whilst the colour-sense is normal, and in the case of congenital dichromats the colour-vision is defective whilst the form-sense is normal.

The essential factor in the perception of colour must be due to some at present unknown reaction, which waves of light of varying wave-lengths produce in the individual cones. As the perception of hues is more acute at the macula than elsewhere, we may infer that the cones in that situation are more capable of undergoing this unknown reaction than those situated in the more peripheral parts of the retina. A comparison of the microscopical appearances of the cones at the macula with those at the periphery of the retina shows very striking differences in them, both as regards shape and size. The foveal cones, especially those in the very centre, are long and slender. The extra-foveal cones decrease in length gradually as

they extend towards the periphery, the change being most marked in the outer segment, which also gradually becomes wider.

Careful histological examination of the cones in the retina of congenitally colour-blind persons might, I suggest, add considerably to our knowledge of colour perception. I have been for some years on the look-out for a specimen in which to make such an examination, but so far have not been successful in obtaining it.

For the perception of colours in the peripheral parts of the field a larger object, intenser light and greater saturation of colour is required than in the centre. Given cones with a hue-perceiving capacity, these requirements might be largely accounted for by varying degrees of concentration of the cones in different parts of the retina. The retinæ of Primates differ from those of lower mammals in having an area, the macula, in which only cones, closely packed together, are present; we should, therefore, expect that the hue-perceiving faculty of Primates would be endowed with a capacity of seeing small patches of colour, colour less brilliantly illuminated, and less saturated, than in those mammals in which the cones are more widely scattered. To put it in another way, we should expect that the colour-sense of mammals, with widely diffused cones, would be comparable to that of the peripheral portions of the retina of Primates.

The perception of small coloured objects is essential for the existence of arboreal animals which live mainly on fruits that they pick up with their fingers. It is by no means essential for the existence of carnivorous or herbivorous mammals. For the former even the capacity of perceiving colour in large masses can have but little use, though in the latter the power of seeing green in large areas might be of some assistance in their search for food. There can be no doubt that bulls in bull-fights are excited into a state of rage by the banderilleros flaunting red cloaks in front of them. I would suggest that the perception of red, presented in this way, excites in them

the same instinctive feelings and reactions as that produced by the sight of flowing blood—the inevitable accompaniment of combats in which the flesh is gored with horns. We ourselves use the expression "seeing red" to describe the feelings which excite us to uncontrollable vengeance.

VI. The Protective Mechanisms of the Eyeball.

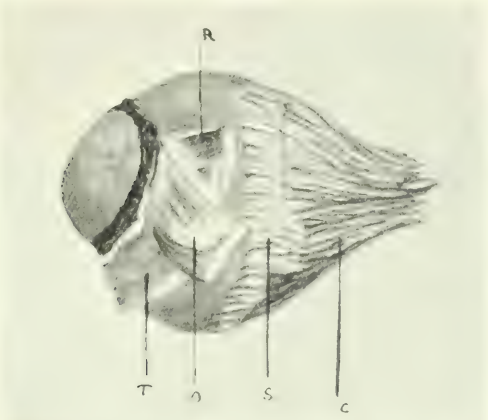
For the development of the conjunctiva it seems essential that the membrane should for a time be converted into a closed sac by the union of the margins of the eyelids together in front of the eyeball. In mammals, like the ruminants, who have to fend for themselves and run beside their mothers directly they are born, the lid margins become separated before birth, so that they are born into the world with their eyes open. The young of nearly all the Carnivora, of most rodents and Insectivora, who spend the first weeks of life in some prepared lair or nest, are born blind, due to the eyelids being still united in front of the eyes. The same applies to the marsupials, whose young for some time after birth are carried about in the maternal pouch. The young of arboreal mammals, such as the lemurs, monkeys and the higher apes, travel about with their mothers from bough to bough directly after birth. The baby monkeys are often carried by their mothers, whilst the baby lemurs cling tightly to their ventral fur. When born into such an environment it is obviously desirable to be endowed with sight, and we find that these arboreal mammals, like the ruminants, enter the world with their eyes open. Newborn children are in many ways quite as helpless as the newborn Carnivora, but, unlike them, the epithelial union of the margins of their eyelids breaks through before birth; this is doubtless an inheritance from their arboreal ancestors.

All terrestrial mammals, with the exception of man and monkeys, possess three eyelids for the protection of the surface of the eye. Man and monkeys have two, the third

eyelid being reduced to a vestigial structure, the semilunar fold.

In birds the third eyelid, or nictitating membrane, is met with in the most highly developed condition; it has in them a muscle directly attached to it which draws it forwards in front of the eyeball. In the Mammifera the movements of the third eyelid are most extensive in the Ungulata, and are produced indirectly by the contraction of a muscle which draws backwards the eyeball

Fig. 16.

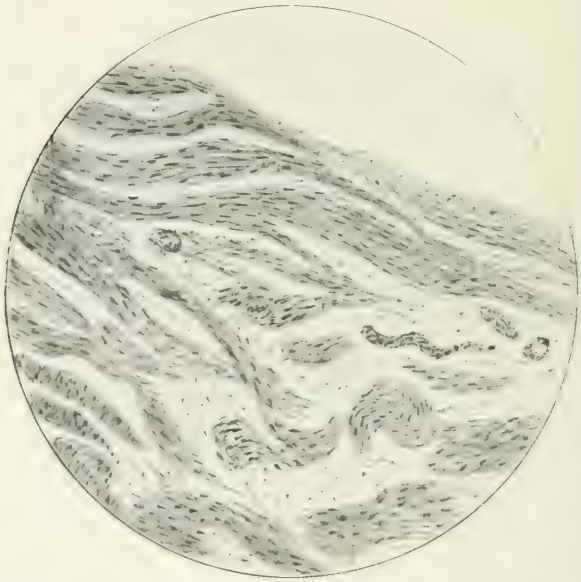


Eye of an antelope showing the retractor bulbi or choanoid muscle (c). s. Sheath of Tenon's capsule external to choanoid. R. External rectus. O. Superior oblique. T. Tenon's capsule.

and pushes forward the orbital fat. The third eyelid in mammals is composed of a plate of cartilage covered on both surfaces by mucous membrane. Anteriorly it has a free even margin fitting accurately the surface of the cornea, over which it glides. Posteriorly it terminates in a considerably thickened edge which penetrates into the depths of the orbit on the inner surface of the globe, where it is continuous with a mass of fat. The muscle which draws back the eyeball—the retractor bulbi—arises from the bones at the apex of the orbit, and is inserted into the sclerotic inside the attachments of the recti

muscles, between them and the optic nerve. It encircles the latter in a cave-like fashion, hence it is often spoken of as "the choanoid muscle" (Fig. 16). When the eyeball is drawn back in the orbit by this muscle the fat of the orbit, with the base of the third eyelid attached to it, is pressed forwards, so that the anterior margin of the eyelid becomes swept across the front of the eye.

Fig. 17.



Section through Gegenbauer's muscle from the inner surface of the cornet of a sheep.

In mammals which possess this choanoid muscle the bony outer wall of the orbit is incomplete, the space between the bones being filled up by a fibrous membrane termed the "cornet," which contains muscular tissue, "the orbital muscle of Gegenbauer" (Fig. 17). In the Primates, who have no third eyelid or choanoid muscle, there is an outer bony wall to the orbit, the only gap in its continuity being the spheno-maxillary fissure.

The retraction of the eyeball by the choanoid muscle causes the contents of the orbit to become pressed against the fibro-muscular membrane filling in its outer wall. It is partly the elastic recoil of this membrane, and partly the contraction of Gegenbauer's muscle, which restores the eyeball to its usual position, and brings about the retraction of the third eyelid.

In association with the third eyelid there is a special gland, "the Harderian gland," whose duct opens on its inner surface, and whose secretion is emptied when the eyelid is pressed forwards, forming a lubricating fluid for the surface of the cornea. Amongst mammals this gland is largest in the Ungulata, whose third eyelid is most mobile, smaller in the Carnivora, and absent altogether in monkeys and man who have no third eyelid.

Some mammals possess both a lacrymal gland and a Harderian gland; where, however, the latter is large and the third eyelid is efficient the former is usually small. In monkeys and man, who have no third eyelid or Harderian gland, the lacrymal gland is larger than in other mammals, and largest of all in man.

The functions of the third eyelid are obvious from its anatomical arrangements, it protects the front of the eye from injurious influences, lubricates its surface, and removes any foreign substance which may become lodged on it. In animals, such as the Herbivora, who when feeding hold their heads close to the ground, and in the Carnivora, who do the same in tracking their prey by scent, the presence of such a protective mechanism is of the greatest service in guarding the cornea from coming in contact with foreign substances, or in their removal should they gain access to the eye.

The grasping of the food in the first place with the hands and the conveyance of it by them to the mouth, as is done by animals who have adopted arboreal life, saves the eyes from much of the risk to which they are exposed when, as in grazing, the food is seized directly with the mouth. The development of the fore limbs into organs of

delicate tactile sensibility, capable of picking up minute particles, has made it possible for them to be used for the removal of foreign bodies from the eye, and thus, as suggested by Le Coq, to play the part of the third eyelid in a way which is not possible for hoofs or claws.

The greater flow of lacrymal secretion in response to the irritation of foreign bodies supplies also an hydraulic apparatus for removal of foreign bodies, to replace the mechanical arrangement of the third eyelid.

Not only has the third eyelid become a superfluous structure in Primates, but the retraction of the eye which its use entails would be a source of trouble and inconvenience to them. The movement of the eyes backward and forwards in the orbit in animals who have assumed the erect or semi-erect posture, would considerably interfere with the accuracy of stereoscopic vision and of accommodation and convergence.

The vestigial remains of the third eyelid persist in man and monkeys as the semilunar fold. Owen (48) says that a remnant of the choanoid muscle is to be found in the lower Quadrumana, in the form of a few fibres detached from the inner part of the recti to be inserted into the sclerotic nearer the entry of the optic nerve. Sir John Bland-Sutton (49) has recently suggested that Tenon's capsule is really the representative of this muscle in man. He says: "A critical examination of Tenon's capsule in the orbit of man and monkeys convinces me that it is the degenerated representative of the retractor bulbi as surely as the little pleat of mucous membrane, known as the semilunar fold, is the vestige or remnant of the third eyelid."

Motais (50) has found the capsule of Tenon constructed in a uniform manner in all classes of vertebrates; it presents, he says, only slight variations due to differences in the arrangements of the ocular muscles. He has published pictures showing its arrangements in the eyes of a horse and of a cow, in which also the choanoid muscle is present. I have found it present myself in dissections

I have made of an antelope (Fig. 16) and of a sheep. It ensheaths, and stretches between, the recti muscles, and forms, moreover, a sheath to the choanoid muscle itself. Inasmuch, then, as Tenon's capsule is found in animals in whom the choanoid muscle is present, it would seem impossible to regard it as a vestigial remnant of the muscle when absent.

Lindsay Johnson (3) states that he met with a case of an obvious membrana nictitans in a youth, which was capable of slight movement and extended in a crescent form nearly as far as the cornea. He does not say, however, whether this movement of the membrane was effected by any accompanying displacement of the eyeball backwards.

Though the evidence of any vestigial remains of the choanoid, or retractor bulbi muscle, is very doubtful, the presence of vestigial remains of Gegenbauer's orbital muscle, or, as I suggest it might be well termed, "the protrusio bulbi muscle," is clear and conclusive.

H. Müller (51) in 1858 first described how he had found flat muscle-fibres in the inferior orbital fissure in man, corresponding to that met with in the orbital membrane of Mammalia. He also described how it was the antagonistic contraction of this membrane, by muscular action, which restored the eyeball to its position in the socket after it had been drawn back by the retractor. The muscle he found was composed of unstriated fibres, and was stimulated into action by irritation of the cervical sympathetic nerve.

Sir William Turner (52) in 1862 wrote an article entitled "Upon a Non-striped Muscle connected with the Orbital Periosteum of Man and Mammals." In it he says: "Whilst engaged in making a dissection in the human subject during the winter session of last year, of the inferior maxillary, or second division of the fifth cranial nerve, my attention was attracted to a pale reddish, soft mass, filling up the narrow chink of the spheno-maxillary fissure, and extending from the sphenoid

fissure in the sphenoid bone to the infra-orbital canal in the superior maxillary bone. It was evidently connected to the superior (ocular) aspect of the periosteum of the orbit, and it was pierced by the orbital branch of the superior maxillary nerve." "Since the period of making the above observation I have availed myself of several opportunities of examining the same region in other subjects, and have constantly observed appearances of a nature similar to that just described. The amount of the reddish mass and the depth of its tint varied slightly in different instances. Frequently it was so pale as scarcely to attract attention, which may perhaps be the reason why it has so long been neglected by anatomists. When carefully examined with the naked eye, or still better with a single lens, it was seen to exhibit a fibrous appearance."

The existence of these unstriated-muscle fibres in man, which may be regarded as the analogue of the "protrusio bulbi muscle" in lower animals, and which is supplied by the cervical sympathetic nerve, is of considerable clinical interest.

First, because it had been noted that slight protrusion of the eyeball, or exophthalmos, may occur from stimulation of the cervical sympathetic, and slight recession or enophthalmos from its paralysis. Secondly, because over-action of this muscle offers the most satisfactory explanation of the exophthalmos which occurs in connection with Graves's disease. As stated by André Crotti (53) the exophthalmos in this affection generally develops slowly, but may come on rapidly. It is liable to fluctuations varying with the physical and mental condition of the patient. It may subside entirely after operation, on the same day as the operation, to reappear again a few days later. It also disappears after death. All these circumstances are consistent with the contraction or relaxation of a muscle which has the power of pushing forwards the globe. The amount of protrusion which its contraction produces would naturally vary with the state

of its development; like other muscles it would tend to hypertrophy and increase in power by prolonged stimulation. By such increase in its power the increase in the amount of the exophthalmos might be accounted for in the cases of long standing.

Another symptom of the disease, viz. retraction of the upper lid, is due to contraction of muscle-fibres supplied by the cervical sympathetic nerve. This muscle, which was also first described by Müller, is also named after him, and, like the muscle about the spheno-maxillary fissure, is composed of unstriated fibres.

A number of other theories have been suggested to account for the exophthalmos in this disease, which may be summarised as follows:

(*a*) Abnormal deposit of retro-bulbar fat.

(*b*) Relaxation of recti muscles from fatty degeneration.

(*c*) Serous infiltration of the retro-bulbar connective and fatty tissue of the orbit from vaso-motor disturbance caused by toxæmia from thyroid disturbance.

(*d*) Venous congestion.

(*e*) Localised arterial dilation.

Post-mortem examinations have failed to substantiate the presence of any of these conditions. Localised arterial dilation would produce pulsating exophthalmos. Venous orbital congestion would, if it produced proptosis, also produce retinal venous dilation—a condition which is never seen. None of these theories will account for the fluctuations in the degree of the proptosis in the way in which contraction and relaxation of a muscle tissue will do.

The effect of the contraction of Müller's muscle in the human eye, situated as it is in the loose periosteum of the orbit, would be, as in other animals, to press forwards the fat of the orbit and consequently the eyeball which lies in front of the fat. Under such circumstances, if, in a case of exophthalmos, an incision was made through the orbito-tarsal ligament, we should expect the fat, being pushed forwards and kept in a state of tension, to well up

through the incision. We should also expect that in extreme cases of exophthalmos, in which ulceration of the cornea was threatened, recession of the eye and beneficial results might attend removal of some of the fat. Foster

Fig. 18.

Showing the arrangement of parts at the inner canthus in different mammals.

Moore [54] has recently recorded how he performed an operation of this description, removing a "heaped-up tablespoon of fat" through an incision which extended the whole length of the lower conjunctival fornix. Afterwards the lids were easily approximated and sewn together over the front of the eye, so that the eye was preserved.

From the result produced in this case he infers, as I think wrongly, that the proptosis must have been due to an excess of fat. The circumstances of the case may equally well be accounted for by a protrusion forwards of orbital fat due to muscular contraction.

Though the vestigial character of the plica semilunaris is well recognised, the vestigial character of the caruncle seems to have been overlooked. A study of the morphology of the parts about the inner canthus of the eye in mammals shows variations of a marked character, not only in the different natural orders, but also in the different species. In kangaroos the inner canthus is prolonged into a triangular flat area, kept moist by the overflow of tears; it is continuous with the skin of the nose and is fringed with fur. A somewhat similar bald area, fringed with fur, is met with in the Carnivora, varying, however, in size and shape in different species. It is amongst the Ungulata that the most conspicuous developments are met with in this region, more especially amongst the ruminants. In them the inner canthus is prolonged for a considerable distance inwards and downwards, sometimes as a thin streak and sometimes as a broad band. The band or streak ends usually in an inverted fold, for the lodgment of which there is, in some animals, a depression in the lacrymal bone. This fold or recess is termed the "suborbital pit," and by French naturalists, as it is kept moist by lacrymal secretion, "larmier." The whole of the integumentary area leading from the eye to the recess and the recess itself is composed of numerous sebaceous glands opening into dwarfed hair-follicles (Fig. 19); at the bottom of the recess a few short hairs are frequently seen projecting from amongst the glands. Around this glandular structure are bands of muscle-fibres, which by their contraction bring about a protrusion of the secreting surface. The secretion from the glands has a strong musky odour, and these suborbital pits reach their greatest size in animals which possess an acute sense of smell; especially is this so in animals such as deer and antelopes,

in whom smell is what may be termed a "distance-sense," in contra-distinction to a contact-sense, such as it is in most of the Carnivora. These odoriferous glandular organs probably form a means by which a stray member of a herd may be guided to rejoin its fellows. They seem

FIG. 19.

Lining membrane of the suborbital pit of a sheep.

also to have some connection with the sexual function, as they are usually larger in the male than the female, and their growth is said to be arrested by castration. In arboreal mammals, like monkeys and anthropoid apes, the sense of smell is of but little use; the olfactory organs are comparatively poorly developed, and the odoriferous organs at the inner angles of eyes have dwindled into

vestigial structures. The caruncle, both in man and monkeys, has become contracted up into a small elevation cut off from any continuity with the skin of the face by the margins of the eyelids, which have completely closed round it, so that it is entirely located in the lacrymal bay. That it really is a vestige of the secreting odoriferous areas met with in other mammals seems evident from its containing remnants of all the constituents of such areas. The following is the description of the structure of the caruncle given in Quain's *Anatomy*: "Occupying the recess of the angle at the border of the plica semilunaris is a spongy-looking reddish elevation (caruncula lacrymalis), formed by a small insulated portion of skin containing a few large, modified sweat-glands, also a group of sebaceous glands which open into the follicles of very fine hairs. There is further found in it a small amount of plain muscular tissue (H. Müller), as well as a few cross-striated muscular fibres." It is also stated that in man, as in some animals, the caruncula lacrymalis retains its connection with the skin at the inner canthus. It is interesting to note in connection with this matter, that the reduction of what must have been a large suborbital pit to a comparatively small bald area at the inner canthus, can be traced in the evolution of the horse. In the skull of the modern horse no depression is found in the lacrymal bone in front of the orbit for such a glandular structure. In the fossil remains of the skulls, from the Pliocene epoch, of the *E. sivalensis* of India and of the *E. stenois* of Europe, traces of the depression or gland-cavity are met with, whilst in the fossil skulls of the Hipparion, a three-toed horse from Miocene beds, there is a very large depression in the bone in front of the eye.

In conclusion, I would claim that the changes in the visual organs of mammals, produced by the adoption of arboreal life, increased both the range and accuracy of their powers of observation for natural phenomena. It was in this way that the portal became opened for the evolution of the mental faculties of memory and inference—

faculties which enabled man's anthropoid ancestors, on descent from the trees, to subdue their foes, to become successful hunters, and to adopt an omnivorous diet. It would seem, therefore, that some such study of the visual organs as I have attempted in this lecture is necessary for fully understanding the way in which man gained his predominant position in the animal kingdom.

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III. DISCUSSION ON THE PSYCHOLOGY OF VISION IN HEALTH AND DISEASE.

Opening Paper.

Instability of retinal corresponding points.

By Prof. C. Spearman.

We see objects in different places: one seems here, another there. The question as to the source of this power is one of the most difficult in all psychology. Generally speaking, the authorities have been divided into two antagonistic camps.

On the one side have been the "empiricists," mostly philosophers, and headed by Berkeley. These, amid great diversity of opinion in detail, have united in regarding visual place as the outcome of experience, and arising through some such process as "association" or "fusion." They have produced notable evidence, including especially experimental data about eye-movements and medical observations about the born-blind suddenly endowed with sight by a surgical operation.

On the other side have been ranged the "nativists," for the most part physiologists, such as Galen and Johannes Müller; these have maintained the power to be essentially innate. According to them, the apparent situation of any visible particle is a "specific energy" of the particular nerve-fibre stimulated. Corresponding to each nerve-fibre terminating in the one retina there is believed to be another nerve-fibre terminating in the other retina possessing the same "specific energy," so that the two visual situations engendered by stimulating the two fibres respectively must necessarily be indistinguishable. These nativists, also, have brought forward a

strong array of evidence. The experimental observations of their opponents have been revised, supplemented, and re-interpreted by them with no little success. And they have been able to show that the pathological cases, on more careful investigation, are really in their favour.

Gradually, however, the old direct antagonism of opinion has been softening down ; the harshly confronting answers of "Yes" and "No" are resolving themselves, as usual, into a mediating "So much."

The primitive standpoint of the philosophical empiricists, that every individual has to rely solely on his own experience, can nowadays scarcely be said to require serious consideration. It is no longer reasonably doubtful that our spatial perception is at any rate partly determined by factors of a hereditary character; if the origin has to be sought in experience, it must at least be in some degree that of our ancestors.

The extreme nativist theory, on the other hand, has never recovered from the breach made in it by Wheatstone, who showed that the pair of images thrown on the two retinæ by any visible particle actually do not, in general, fall on "corresponding" points of the retinæ; it is, in fact, their very deviation from "correspondence" that furnishes our chief criterion of distance and depth. He brought evidence, too, that such a pair of images, though thus falling on non-corresponding points, can nevertheless be seen as a single image. He even tried to demonstrate that, conversely, a pair of images really falling on corresponding points may still on occasion appear as double.*

This investigation caused considerable perturbance in the camp of the nativists. They found themselves impotent to contest Wheatstone's main proposition, that the images do not correspond, and that this very non-correspondence produces the appearance of depth. But a struggle was made against the further assertion, that non-corresponding points could engender single vision. And

* *Philos. Trans.*, vol. ii, 1838.

when, eventually, this also had to be conceded, only the more resolute was the stand made against Wheatstone's final claim, that a pair of images really falling on corresponding points may still appear as double. Volkmann, for instance, declared that the admission of such a claim would cause "the whole theory of the identity of the two retinæ" to be "lost beyond salvation."* And, indeed, they managed to detect grave flaws in the demonstration of Wheatstone†; they even contrived to throw serious doubt on the newer and highly ingenious evidence brought forward by Wundt.‡

At present their general attitude is that the old theory holds strictly true only for the vision of a single eye functioning apart. Here the apparent place of any visible particle is said to be innately and strictly determined by the "specific energy" of the nerve-fibre stimulated. But to explain the vision of the two eyes together they have to bring in a supplementary theory. Even in this case the apparent situation of the object is held to be innately fixed, the depth being governed by the degree of non-correspondence between the two images. But one large concession is made: it is admitted that sensation, though deriving from non-corresponding points, may still undergo a peculiar "psychic fusion" so as to seem, not double, but single. This view appears to have generally gained the day, being accepted by the large majority of physiologists and psychologists.

There are indications, however, that the concessions will have to go still further. The interesting discovery has been made by Straub that perception of depth is produced by non-corresponding points, not only in the two retinæ but also in the same retina, when these are stimulated in rapid succession. Whence he concludes that the binocular perception of distance must be merely

* *Handwörterbuch d. Physiologie*, iii, 1846, p. 1; *Archiv f. Ophthalm.*, V, 2, 1859,; *Phys. Unters. im Gebiete d. Optik.*, 1863.

† See Brücke, *Muller's Archiv*, 1841, p. 459.

‡ See Wundt, *Zeit. f. rat. Med.* (3), xii, 1861, and Hering, *Hermann's Handbuch d. Physiol. Raumsinn des Auges.*, 1862.

derivative from the far older uniocular perception of it.* More recently similar results and conclusions have been reached by Watt.† Above all, most ingenious evidence has been produced by Sherrington, that "the binocular sensation attained seems combined from right and left uniocular sensations elaborated independently." ‡

The present paper offers a new figure in support even of the most advanced claim of Wheatstone and Wundt, which the nativists declared to be so utterly incompatible with their main theory. It indicates that two retinal points, although truly "corresponding" and normally producing the same visual situation, can nevertheless under certain circumstances engender different visual situations. Moreover, even this discrepancy is not rigidly fixed; the curious spectacle may be presented of an object moving plainly backwards and forwards, although all the time the place of retinal stimulation remains unchanged.

The chief difficulty in devising an experiment to give crucial results is that, when the object regarded by both eyes appears single, we usually cannot prove this singleness to be really due to a fusion of the two impressions rather than to a mere suppression of one of them. Even the fact of the object exhibiting stereoscopic depth has been shown to be inconclusive in this matter. Also, there is always the danger of illusory results owing to some unsuspected rotation of an eye.

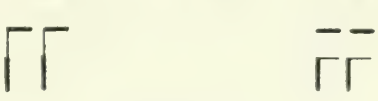
The following visual arrangement, however, overcomes, it is believed, all these difficulties. One part serves merely to induce the abnormal deviation of apparent direction. It is constituted of all the thick lines in the figures below. It is similar for both eyes, except that those for the left eye are 1 mm. further apart laterally than those for the right eye. The crucial test is made up of the thin lines; these are vertical for the left eye, but horizontal for the right one.

* *Zeit. f. Psychol.*, xxxvi, 1904.
† *Brit. J. Psych.*, vol. iii, 1910.
‡ *Ibid.*, vol. i, 1904.

If, now, the whole arrangement be presented in a stereoscope, *a* to the left eye and *b* to the right one, *a* and *b* will readily fuse into two figures in such a manner that the thin lines present simultaneously the appearance of two L's.

But if objects seen by corresponding retinal points necessarily appeared in the same direction, then, when the thin lines on the left of *a* and of *b* respectively combined into L, the other two thin lines would necessarily appear as ⊥. For the distance between the two vertical thin lines is equal to the distance from the left extremity of the left horizontal thin line to the *centre*, not the left extremity, of the right horizontal line. In other words,

FIG. 20.



Arrangement I.

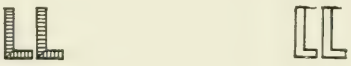
the bottom of the right vertical line and the centre of the right horizontal line must be stimulating corresponding retinal points; yet they give rise to different visual places.

A similar result can be got from another visual arrangement, making use of two different colours. If in the arrangement below, the two vertical lines for the left eye are coloured a pale pink while those for the right eye are made a complementary pale green, the continued functioning of both eyes can be proved in the strictest possible way by the binocular image becoming grey. This already suffices to prove that disparate points can engender a singleness of vision over and above anything that can legitimately be called "confusion." But more definite evidence is furnished by the appearance of the two thin lines during the combination; for it will be noticed that both can lie with their left extremities touching the thick verticals; and hence, by analogous reasoning to that given above, at least one of these

extremities must have a different apparent place from that given by the corresponding point of the other retina.

FIG. 21.

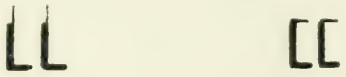
Pink. *Green.*



Arrangement II.

The oscillating movement mentioned above can be obtained by weakening the inductive influence as in the arrangement below. Here, occasionally, the two thin lines in the left figure can be seen quite steady at the very moment that the two thin lines in the right figure are shifting relatively to one another. This can only mean that the localisation appertaining to certain nerve-fibres in one retina is fluctuating. This experiment, like the preceding one, seems to require more practice to get any clear results than does Arrangement I.

FIG. 22.



Arrangement III.

It would be interesting to learn how far the above experimental evidence, indicating our perception of direction not to be irrevocably fixed innately, is supported by recent pathological observation. Cases have been reported where the habit of squinting has resulted in one retina dropping its old spatial values for new ones harmonising better with the other retina. Indeed, sometimes the new values are said to be acquired before the old ones are dropped entirely, so that one and the same retinal group of nerve-fibres evokes two differently localised perceptions simultaneously. But on the other hand, these reports have sustained criticism.*

* See Schoen, *Zeit. f. Psych.*, xxxv, 1904.

The net result of all these considerations is to incline the balance slightly more than before in the direction of empiricism as opposed to nativism. But of course it is far from supporting the former extreme view, which regarded the mind of the newborn babe as a blank sheet to be filled in solely by experience. The experiments indicate, on the contrary, that the localising function of the visual nerves can only be modified with difficulty and within narrow limits. The old empiricism, which attempted to explain all mental processes by individual development, must turn to explanation by racial development. Ontogenesis must give place to phylogenesis.*

Opening Paper.

The evolution of visual perceptions.

By J. Herbert Parsons.

The psychology of vision is so enormous a subject that the opener of a discussion upon it cannot hope to cover it even in the most sketchy manner.

Vision is one of the latest evolved of the senses. It belongs to that group which Sherrington has termed projicient. There can be no doubt that the earliest evolved sentient response to stimuli from the outer world was of the contact order. We are unable to realise its nature, but there is a good reason to think that it must have been vague, massive and undiscriminating, carrying with it a pleasurable or unpleasurable affective tone, and giving rise to a positive or negative motor taxis. It may be conjectured as having many of the characteristics which have been ascribed to what Head calls protopathic sensation, though it must have been far less differentiated than even this relatively undifferentiated sensory experience. Probably the sentience to which it gave rise in lowly organisms arose from stimuli of considerable

* For such an attempt by the present writer see *Mind*, vol. xvi, N.S., p. 181.

physical variety—mechanical, chemical and thermal—and only at a later stage was that sentience differentiated into sensations which varied according to the quality and intensity of the various physical stimuli. With this stage arose the germs or tactile, thermal and painful sensations. Of these the tactile and painful were doubtless primitively prepotent. Later differentiations were of the epicritic type, leading to more accurate discriminations in various directions.

The response to thermal stimuli was the genesis of an irritability to radiant energy, and the further stage of response to light stimuli is, from the physical point of view, a further differentiation of the same nature. It marks a notable stage in evolution, for it is the beginning of the development of the projicient senses. These senses are subserved by end-organs which are distant receptors, *i. e.* they receive stimuli from objects at a distance from the organism, and subjectively they project the sensation experienced into the outer world in the direction from which the stimulus comes. It is clear that this step, overpassing the narrow limits of experience derived from contact stimuli, opens up a greatly expanded knowledge of the outer world, and therewith the capacity for much greater control of the organism's environment, and this, it must be remembered, is the true criterion of higher and lower in the evolutionary scale.

The projicient senses, as we know them, are the olfactory, visual and auditory, *i. e.* chemical, radiant and mechanical, so far as their physical stimuli are concerned.

Sherrington, in his epoch-making *Integrative Action of the Nervous System*, has shown how with the fore and aft arrangements of its segments the animal body attained its first opportunity for high differentiation; how the leading segment, the head, attained supreme importance, an importance immeasurably enhanced by the collection of the projicient sense-organs, or distance-receptors, in this *leading* segment. For the distance-receptors, owing to the projicience of the sensations to which they give

rise, initiate anticipatory or precurrent reactions, and by virtue of this function marshal under their sway the reactions of all the other segments initiated by their various contact exteroceptors. Psychologically considered the distance receptors are the seat of origin of conative impulses. "It is the long serial reactions of the distance receptors that allow most scope for the selection of those brute organisms that are fittest for survival in respect to elements of mind. The distance-receptors hence contribute most to the uprearing of the cerebrum" (Sherrington, *loc. cit.*, p. 333). Indeed, Sherrington goes so far as to say that "the cerebrum itself may be indeed regarded as the ganglion of the distance receptors" (*loc. cit.*, p. 353).

Just as the distance receptors in the head segment dominate the reactions of the exteroceptors in the rest of the segments, so the labyrinth in the head, together with its ganglion, the cerebellum, dominates the proprioceptive system, and so the posture of the body and its parts. We are too apt to forget the importance of the proprioceptive system. For example, the discrimination of two points by the compass test applied to the skin is too often regarded as a mere phenomenon of the exteroceptive system. It is a far more complex phenomenon, in which the mobility of the parts—and therewith the proprioceptive reactions derived from muscles, tendon and joints—is fundamentally concerned. Similarly, ophthalmologists are prone to regard the phenomena of binocular vision as themselves sufficient to account for judgments of distance, etc., forgetful of the fact that these depend upon standards of posture and direction which are derived from the labyrinth and other parts of the proprioceptive system. The physiological integration of visual impulses with those of the vestibular apparatus, cerebellum and other parts of the proprioceptive system, anatomically subserved by complex synaptic mechanisms and long internuncial paths, is thus the so-called "physical" basis of psychological phenomena whose frequency and familiarity mask their complexity except to careful analysis.

Thus a new object presented to the perceptive field, *e. g.* vision, arouses an awareness, which if sufficiently striking may develop into attention. Both are phases of conative feeling, and therefore are motor in their fundamental character. Each is accompanied by an appropriate postural attitude, an alertness which may be maintained unaltered for a considerable time. These tonic postural conditions are brought about by the proprioceptive system.

Incidentally it may be remarked here that the tonus of exteroceptive reactions is short in duration as compared with that of the proprioceptive. Hence, if the former reaction has to be maintained, recurrence of stimulation or alteration of the exact site of stimulation must occur. This fact may be one reason for the unconscious—or better expressed in Rivers's terminology, the "unwitting" —blinking of the eyes during accurate fixation, and may account for nystagmus of peripheral origin.

A simpler example of the support given to psychological analysis by biological and physiological arguments is found in the integration of the impulses derived from the distance-receptors of different modalities, all collected where they can best reinforce each other in the head-segment. In this manner the differentiated sensations derived from sight and hearing, and in lower animals from smell, are all integrated into perceptions which carry with them a meaning which is of biological significance to the animal. In its simplest form this is the basis of the concept of a "thing" in the external world, characterised by "properties."

In a previous article (*Brit. Journ. of Ophthal.*, 1917, vol. i, p. 426) on "The Apocritic Principle and the Evolution of Visual Perceptions," I dealt with the differentiation, selective segregation and creative synthesis of visual perceptions. I take this opportunity of elaborating some of my remarks from a somewhat different point of view.

The resemblance of the retinal neuro-epithelium to tactile spots in the cutaneous surface is patent. But the resem-

blance to thermal spots is in some respects more illuminating, as might, indeed, have been anticipated, since the stimuli are in each case radiant energy, though of different wave-lengths. As Sherrington says, the retina is a group of glorified "warm" spots, just as the cochlea is a group of glorified "touch" spots. Thus, in cutaneous thermal sensations, as has been clearly brought out by Trotter and Davies (*Journ. of Phys.*, vol. xxxviii, 1909), there is a well-marked indifference range, varying with the temperature of the skin at the moment. This condition of the skin has a striking analogy to the condition of adaptation to light of the retina, and the temperature thresholds and contrast phenomena are similarly analogous to brightness and colour contrast phenomena in the eye.

Visual sensations may be divided into various kinds, of which the light-sense is undoubtedly the most primitive. It differs from the other kinds in its vagueness and relative lack of discriminative features. In this respect it bears the same relation to them which protopathic does to epicritic sensations. In the view which I have advanced of the evolution of visual sensations the light-sense and the form-sense, colour-sense, etc., form stages of phylogenetic evolution, but the former persists in modified form in the higher stages in accordance with the apocritic principle. According to Head protopathic and epicritic sensations are two distinct stages in phylogenetic evolution, and the latter replaces the former. Trotter and Davies's experiments appear rather to support my view. If it is justifiable to use the terms "protopathic" and "epicritic" in a slightly different sense from that employed by Head, one may say that the protopathic light-sense is specially associated with activity of the rods, epicritic colour-sense with that of the cones, which are undoubtedly differentiated rods. There is evidence that the protopathic light-sense persists throughout the conditions of retinal adaptation and stimulus intensity which arouse the epicritic series of reactions, though the evidence is not unequivocal. For example, in total colour-blindness the retina behaves

at low intensities exactly like the normal eye, but at higher intensities it continues to behave in the same manner, though photophobia soon supervenes. It is probable that at higher intensities in the normal eye the protopathic effect is superadded to the epicritic, and perhaps contributes to the brightness of the sensation experienced.

Special features of protopathic sensation, in Head's use of the term, are its "all-or-none" reaction and its tendency to initiate a "mass reflex" (*cf.* Rivers, *Instinct and the Unconscious*, 1920). The protopathic light-sense, so far as it has been investigated at present, does not exhibit either of these characteristics. But if we regard it in its primitive manifestation it is more than probable that it then exhibited both. In higher animals it has become differentiated into the epicritic phases, but still persists in modified form underlying the epicritic manifestations. The primitive protopathic light-sense we must regard as vague, diffuse, and not accurately localised. If it persisted in this form unmodified, when the light-sense became more definitely projicient it would interfere with exact discrimination. The suppression of these features, however, has become complete only in the macula, the area of distinct vision. Further, the projicient senses, as already mentioned, are concerned with the initiation of anticipatory or precurrent reactions. It is the contact exteroceptors which are specially concerned in consummatory reactions (Sherrington, *loc. cit.*, p. 329). Anything in the nature of a mass reflex action to projicient sense stimulation would frustrate the object of this adaptive mechanism: hence the modification of such a response from the protopathic light-sense. Here projicience implies anticipation, and anticipation demands positive phototropism—a turning of the eyes towards the light. (We may suspect that in its most primitive form the protopathic light-sense elicited much more definite affective tone.) As Rivers (*loc. cit.*, p. 32) points out, "such elements (of protopathic sensation) as are serviceable are utilised when the later and higher forms of sensibility come into existence. . . .

It is only those features of early sensibility which are incompatible with later developments which are suppressed." In psychological phraseology, just as in the interference of antagonistic reflexes which both use a common path, incopresentability leads to adaptative suppression.

The protopathic light-sense, or in the terms of the duplicity theory, "rod vision," is specially sensitive to *change* of site of stimulus, and therefore contributes largely to the appreciation of *moving* objects. It belongs, indeed, to the group of what have been called "change sensations" (H. J. Watt, *Brit. Journ. of Psych.*, vol. iv, p. 157). It has been noticed by G. Riddoch (*Brain*, vol. xl, p. 15, 1917) that in recovery from war injuries of the occipital lobes perception of movement precedes that of the moving object, and that the recovery of movement vision begins at the periphery. He therefore concludes that the consciousness of "something moving" should be recognised as one of the visual perceptions. This is on a par with the ascription of the discrimination of two points applied to the skin to a simple phenomenon of exteroceptive sensation. The question is really a much more complicated problem in psychology. It depends upon the fact that stimulation of different spots on the skin or retina by respectively exactly similar stimuli produces different effects in consciousness distinguished from each other by difference in local sign. These local signs are due not only to the local diversity of the spots stimulated, but also to innate and acquired mental characteristics. In all sense-presentations we can discern quality (or modality), intensity, and protensity or duration; in some, to which tactile and visual belong, we can also discern extensity. During the long process of evolution the motor reactions to external impressions have led to differentiations and adaptations, many of which have been inherited; on the basis of these the acquired knowledge of the parts of the body, particularly in infancy, has resulted in such discrimination of the parts of the body that each distinguishable part has acquired a local sign,

and these local signs have an invariable relation to each other. It is therefore not surprising that the primitive undifferentiated extensity should be associated with protopathic sensations, and should remain more closely attached to them in the course of later differentiation. A body brought in contact with the skin arouses passive touch, which is localised. A moving hand, exploring the surface of a body, arouses active touch, which is in some slight degree projected (*cf.* J. Ward, *Psychological Principles*, p. 152). In passive sight, as it may by analogy be called, the whole field of vision is simultaneously received, and any specially prominent feature in it is localised. Movement of the object within the field arouses change of local sign, altered localisation—the impression of movement. But a prominent object in the field also stimulates active sight, *i. e.* movement of the eyes to fix the object with the fovea. In the former the judgment of movement is a complex synthesis of all those inherited and acquired factors derived from the integration of exteroceptive and proprioceptive sensations, the protopathic factors being predominant in the exteroceptive system. In the latter the judgment of form, colour, position in space, etc., is also derived from the integration of exteroceptive and proprioceptive sensations, but the epicritic factors are predominant in the exteroceptive system.

Peripheral vision is more rapidly fatigued than central vision, but being predominantly protopathic it retains some of its primitive insistency to attract attention, a survival which is aided by its alliance with a projicient sensation, whose function is predominantly anticipatory. Rapid fatigue is more than compensated for by the acquisition of heightened mental capacity to appreciate change of local sign: it may, indeed, be advantageous.

Turning now to epicritic visual sensations, they may be divided into various groups and subgroups. First are those associated with form-vision; next those associated with colour-vision. These appear to be inextricably intermingled, and only to a slight degree open to psycho-

logical analysis. In the past too much stress has undoubtedly been laid upon the phenomena occurring in the peripheral organs. The parts played by these can be discovered only by inference, derived from the application of physical and physiological science to the fully developed perceptions as they manifest themselves in consciousness. Thus as regards colour-vision, there are two great bodies of facts which are independent of any theory: (1) Those derived from the laws of colour mixture, showing that in terms of physical stimuli colour-vision is tri-chromatic; and (2) those derived from simultaneous and successive contrast, supporting the view that, psychologically, colour-vision is tetrachromatic. The two great theories of colour-vision, those of Young and Hering, are founded on these two groups respectively; and it is notorious that while each theory explains more or less satisfactorily one group of facts, the other group can only be reconciled with it by arguments which are strained and unconvincing.

It would be remarkable if there were no elaboration of the impulses set up in the retina by light stimuli during their long and complex journey from the retina to the basal centres, and from there to the visual cortex. Head has shown that dissociation and rearrangement of cutaneous impulses occur in transit from the peripheral end-organs through the spinal cord and again from the basal centres to the cerebrum. These facts have been elicited with great difficulty in the domain of cutaneous sensation by careful observations of changes resulting from experimental and pathological lesions. The problem is even more difficult for vision, but the dissociation of the higher epicritic visual sensations from the protopathic seems to be exemplified in total colour-blindness; and it is possible that groups of partial colour-blindness are similar examples of dissociation occurring within the higher epicritic sensations. It appears to me that it is in this line of thought, which we owe entirely to Head, that the reconciliation of the phenomena of colour vision is to be sought.

I propose next to discuss some features of binocular vision.

In all vertebrates below the mammals there is total decussation of the optic nerves. Some degree of binocular vision is rendered possible in some of these lower vertebrates by such position of the eyes that the visual fields overlap, *e. g.* certain fishes (shark, ray), toad, birds (gulls, owls, hawks, vultures). It is noteworthy that all these animals are carnivorous (Harris, *Brain*, vols. xxvii, p. 107, 1904).

Biologically, therefore, binocular vision may be regarded as primarily an adaptation in the interests of self-preservation, specially associated with the pursuit and capture of prey, and to a less extent in the interests of self-defence. Physiologically its function is the attainment of better motor adaptation, progressively improving in this respect as we ascend the series and reach the primates, and more particularly in two directions: (1) In the development of the highest form of epicritic vision, with macular vision, and perfect binocular fusion and stereoscopic vision; and (2) in the ever-increasing complexity of functional association with other exteroceptive and proprioceptive systems. Anatomically these functions are subserved by structural changes, increasing number and complexity of internuncial association paths, important changes in cerebral structure, and gradual increase of the direct fibres in the optic tracts. The cerebral changes are "the appearance of an occipital lobe, a line of Gennari visible to the naked eye, a deep layer of pyramids with a double layer of granules in the visuo-sensory striate area. But even more important than this is the appearance of a definite associational zone in which there is a much greater depth of pyramid cells, the third layer of which is characterised by very large pyramids serving as higher complex association neurons between the visual cortex and the auditory and tactile motor areas" (Mott, "Bowman Lecture," *T.O.S.*, vol. xxv, ci, 1905).

It is instructive to select types as stages of this progressive development of binocular vision.

(1) The chameleon, in which the independent roaming of

the eyes in search of prey is suddenly replaced by accurate convergence at the moment of striking.* Although a true macula is not found until the monkeys, an area centralis of greater anatomical differentiation and probably more discriminative function is found in many lower animals, and among them, according to Ramon y Cajal, the chameleon.

(2) The cat, the lowest mammal in which section of the optic tract causes hemianopia (Harris). The cat is also distinguished from other mammals of its own evolutionary stage, such as the dog, in possessing the power of convergence of the eyes, *i.e.* eye-movements independent of the head movements (Harris). It seems probable, therefore, that the cat has stereoscopic vision, and that this is associated with the prehension of prey by the fore-limbs.

(3) The monkey, in which a true fovea is developed and conjugate eye movements are of great range and variety, upward movements showing a decided advance as compared with lower mammals. These movements are associated with improved stereoscopic vision and adaptation to arboreal life.

(4) Man, in which the perfection of visual sensations, conjugate movements and stereoscopic vision is reached. This is associated with the erect posture, the abandonment of arboreal life (? the adoption of the hunting habit, *c.f.* Carvell Read, *The Origin of Man*, 1920), and a struggle for existence, in which success is attained by superiority of mental capacity.

As already stated, Sherrington has shown how in the higher animals the projicient senses dominate their activities. In the lower mammals the olfactory sense dominates; in birds the visual. In some, *e. g.* the Carnivora, the olfactory dominates the pursuit of prey, the visual the capture of prey. In others, *e. g.* horse, ox, rabbit, deer, olfactory and auditory combine as sentinels of danger. In man vision is prepotent, but all combine in psychological "complication."

* This is denied by Hess in Winterstein's *Handbuch der Vergleichenden Physiologie*.

It is interesting to compare the crossed relationship of both motor and sensory apparatus in vision and in other reactions. In myxine the optic nerves pass to the optic lobes directly, without decussation. In animals with total decussation the right side of the brain receives visual impressions from the whole of the left retina, derived from the environment on the left side of the body. In animals with semi-decussation the right side of the brain also receives impressions from the environment on the left side of the body, but they are derived from the right halves of both retinæ.

Sherrington (*loc. cit.*, pp. 384–5) has shown that the peculiarities of cortical representation of lateral conjugate movements of the eyes can be explained by reference to Hering's cyclopean eye. Here the left frontal area is the "centre" for conjugate movements of the eyes to the right, *i. e.* it sets in action the right external rectus and the left internal rectus, and reciprocally inhibits the right internal rectus and the left external rectus. If the eyes be imagined superposed in the sagittal plane, then the right cortical centre dominates the muscles on the left sides of the superposed globes. The ocular musculature is thus brought into line with that of the rest of the body, in that the cortical representation of muscles on the one side of the body is found in the opposite side of the brain.

If the same device is applied to the afferent mechanism it will be seen that the right halves of both retinæ send all their impulses to the right occipital lobe. The decussation is thus a functional one, projicience to the left being represented in the right cerebral hemisphere.

Of the innumerable stimuli which shower upon the individual at any given moment, most are suppressed or at any rate contribute only their quota to cœnæsthesis. Only those of interest are attended to, and these are synthesised into perceptions which carry meaning, and thus crystallise the relative biological importance of the experience to the individual. These perceptions occupy the

focus of the field of consciousness. The other stimuli arouse impulses which are either completely inhibited, since they would otherwise conflict with those selected and segregated, or else they contribute only a vague impression in the periphery of the field of consciousness. The fact that the terminology used is borrowed from visual phenomena—the fixation point and the field of vision—shows that allied processes of partial or complete suppression are familiar facts in vision.

In the panoramic vision of lower animals it is probable that there was far less rivalry between the different parts of each visual field. The development of a macula, and particularly the connection of each foveal cone with a single bipolar cell, must have tended to increase discriminative capacity, but at the cost of raising the threshold of response. In the panoramic eye the threshold was lower, and, as we have seen, consciousness of movement of objects was extremely acute. It can scarcely be doubted, however, that some degree of suppression was associated with the awareness of, and attention to, the exciting moving object. Still more one would conjecture that at this moment the whole field of the opposite eye was suppressed. Thus suppression of the impressions derived from one eye must have occurred very early in the phylogenetic scale.

When perfect binocular and stereoscopic vision was evolved the eyes were so placed that suppression of all the impressions of one eye became unnecessary. The two eyes formed a unit, which for functional purposes might be regarded as a single sagitally placed cyclopean eye, and under ordinary conditions of vision the impressions derived from disparate points alone required suppression. How far this suppression is complete, or incomplete, contributing subconsciously to visual perceptions, is a disputed point, but it is certain that it is relatively complete.

Sherrington's beautiful experiments on binocular flicker (*loc. cit.*, Lecture X; *Brit. Journ. of Psych.*, vol. 1, p. 26, 1904) have proved conclusively that no summation of the

impulses derived from the two eyes occurs. If, however, conflict is established artificially between the two eyes, as by covering one with a red, the other with a blue glass, retinal rivalry occurs. Under these circumstances, though objects may momentarily appear purple, they are more often seen to alternate between red and blue, *i. e.* the image of one or other eye is temporarily suppressed. Like other cases of psychological suppression, this is an example of the unwitting suppression or inhibition of the immediately painful or unpleasant conflicting impression. From the biological point of view it may be looked upon as an example of regression, or what Hughlings Jackson called "devolution"—in this case a return to the suppression associated with panoramic vision. It must be remembered that binocular fusion of images is phylogenetically a late adaptation; reversion to an ancestral type is therefore relatively easy.

These considerations appear to me to throw some light upon the suppression of vision in one eye in concomitant squint. The suppression of alternating squint is a glorified form of retinal rivalry. In ordinary convergent squint the suppression of the image of the squinting eye is a perfect example of the unwitting suppression of the immediately unpleasant experience, viz. that of double vision. Like other examples of suppression it is most liable to occur, and to be most complete if acquired in the early years of life. The attempt to suppress the false image in a paralytic squint is an excellent example of what Rivers calls repression, *i.e.* conscious or witting suppression. Like other examples of repression it is always unsuccessful directly, though it may be indirectly more or less successful if associated with some cause of unwitting suppression.

If, then, the suppression of the image of the concomitantly squinting eye is of the same nature as other examples of psychological suppression, does the suppressed image persist potentially in the unconscious, as it certainly does in many other cases? If it does, it is conceivable

that it might be revived by hypnosis. I advance the suggestion with diffidence, because I do not for a moment think this would be possible. Apart from the fact that the suppression generally occurs very early in life, it is probably a devolution or reversion to the panoramic stage of vision. Whether it is the suppression of individual experience occurring in early infancy, or of racial experience belonging to a very early phylogenetic stage, it is improbable that the experience could be recalled by hypnosis or any other means at present known.

The absence of diplopia in paralytic squints of congenital or very early infantile origin may be explained in the same manner.

Sherrington's binocular flicker experiments have proved conclusively that there is no fusion or interference between the impulses derived from corresponding retinal points at a low physiological level. If there were, summation would occur and Talbot's law would hold good. That no such fusion occurs is what might be expected in a function of such recent phylogenetic origin as stereoscopic binocular vision. As Sherrington states: "During binocular regard of an objective image each uniocular mechanism develops independently a sensual image of considerable completeness. The singleness of the binocular perception results from union of these elaborated uniocular sensations. The singleness is therefore the product of a synthesis that works with already elaborated sensations contemporaneously proceeding." "Here we seem to have, therefore, contemporaneity of itself sufficing for sensual synthesis, without necessarily any spatial fusion of the neural processes or mechanisms involved, *i. e.* without spatial confluence to a unit apparatus."

The phenomena of vision and the motor responses associated with them show that it is unsafe to draw positive conclusions as to sensory syntheses from analogy with the neural mechanisms which synthesize reflex movements. When we consider that the primitive motor reaction is a reflex, of machine-like fatality, precise and well-defined as

the result of age-long perfecting, whereas the primitive sensation is a vague, diffuse and ill-defined "psychoplasm," it is not surprising that their later evolution should present contrasting features. The latter, by a process of differentiation, selective segregation and reintegration becomes highly discriminative, while the former, by complex processes of summation and interference, loses its stability and fatal inevitability and attains plasticity under the control of higher centres.

In conclusion I venture to express the hope that these scattered remarks may help the cause of both ophthalmology and of psychology. For I am convinced, on the one hand, that ophthalmology cannot afford to ignore psychology; on the other, that the only sure foundation for the science of psychology is biology and physiology. To quote yet once more from Sherrington: "Physiology and psychology, instead of presenting their studies, as some now recommend, more strictly apart one from another than at present, will find it serviceable for each to give to the results achieved by the other even closer heed than has been customary hitherto."

Sir Robert Armstrong-Jones, C.B.E.:

In the first place let me express my appreciation of the able and interesting as well as suggestive paper read by Mr. Parsons, also the scientific contribution of Dr. Spearman, to whom I am personally indebted for much help in regard to some of the psychological problems connected with the phenomena of the sense of vision. I am much indebted to the Ophthalmological Society for the recognition of my particular speciality in this discussion, but I fear that my contribution will fall far short of the scientific standard set before the conference by previous speakers.

I must apologize for the shortness of my contribution, but I would like to commence by stating that it is rare to find eye diseases to be the starting point of disorders of the nervous system. I had careful and serial examinations made of the retina in hundreds of admissions of mental

cases received into Claybury, and no constant findings were discovered apart from insanity associated with tabes or general paralysis of the insane or cerebral tumours, although functional disorders of sight and the strain of mental effort to overcome errors in refraction not infrequently caused mental symptoms. In one case, about which I wrote to Mr. Ernest Clarke some years ago, a woman suffering from extreme myopia, different in degree in the two eyes, had attempted suicide from the constant headache suffered. She had been brought into the asylum in an acute state of melancholia, and recovered completely when the refraction was relieved by proper glasses. On the other hand disease of the nervous system may cause marked changes in the sense of sight. I have often noted marked hyperæsthesia of the retina accompany exhaustion, and so common is this that immense relief of this mental erethism is obtained by seclusion in a dark room, and some mental patients will ask to go into the padded room (which is darkened by a shutter) for the relief of asthenopia and hyperæsthesia after exhaustion. It is common knowledge that day-blindness will result from imperfect restitution, and a dazzling feeling is often experienced after impaired nutrition, which means that excessive photo-chemical decomposition has occurred without corresponding restitution, but which is restored by rest and darkness.

It is well known that many of the psychoses follow toxic causes; and alcohol, cannabis indica, santonin, tobacco and the auto-toxæmic states, the poison of fevers, all give rise to visual rather than to any other sensory hallucinations. The poison of syphilis more often affects the sense of sight rather than that of hearing, probably being analogous in the ciliary ganglion (with its motor, sensory and sympathetic fibres) to affection of the neurons in the posterior spinal nerve root ganglia in tabes and of the cortical neurons in general paralysis of the insane. In the ciliary ganglion the motor or short root is derived from a branch of the motor oculi (which passes to the inferior oblique),

the sensory from the naso-ciliary nerve after its passage into the external rectus (long root), and the sympathetic from the carotid plexus, passing thence into the ciliary muscle, the sphincter and dilator of the pupil, and also into the choroid, iris and ciliary body—with the results so well known in the Argyll-Robertson phenomenon.

In dealing with the psychology of the sense of vision the mental aspect of feeling tone is most important—what has been described as the hedonic tone. As we know, in every sensation there is an attitude of the subject in the presence of an object, each sensation having its own state of feeling-tone. Crude colours—an ugly dress—give pain, just as discordant sounds do, and we shrink from the painful and try to avert it, just as we seek to continue the pleasurable.

In vision we tend to dwell upon a pleasurable landscape with its mountain, river and sea elements: we remember it and wish to re-visit it. The wall-paper of a room or the colour of a motor car attracts us, and a state of mind is produced in which the cognition of the beautiful, the feeling of the emotion kindled and the conative tendency of activity come into force. All states of pleasure are not associated with any one sense: one form of pleasure may be in the search for truth, *i. e.* in intellectual exercise; another may be in seeking the good, which is moral pleasure, and generally harmony is pleasant, whilst discord is the reverse; an ill-expressed verse jars and gives pain, whilst rhythmic sounds such as poetry and rhythmic movements such as dancing—which is a unity between movement and sound—give a pleasurable feeling-tone, just as a dragging walk or a halting gait gives pain. The same with ideas, for as thinking is a means to an end, ideas that are relevant are a pleasure, whilst ideas that refuse to fit into the conceptual system conflict and give pain, so that confused thought is a hindrance and a dissatisfaction. Conscious activity normally exercised is a pleasure, whilst baffled attention and inadequate efforts give pain, and, as Bain stated,

pleasurable sensations tend to increase the vital activity, whilst painful ones do the reverse.

In the sensation of sight we have a sense which is not intercommunicative like hearing, and therefore vision is secondary to hearing in importance. All the traditions of the past have been handed down by intercommunication, *i.e.* by hearing often translated into script, so that hearing is the most highly evolutionised of all the senses, the most highly developed and therefore the least organised and the most easily disturbed, and is the one most often affected in the confirmed psychoses. Moreover, as compared with sight, it embraces more octaves and has more vulnerable points for attack by disease.

The mode of appreciating sensation through sight is by *light, colour, form,* and *lustre, i. e.* it is partly *optical* and partly *muscular.* As we look at *colour* we converge, and a sensation of *sight* is rarely without the feeling of convergence and the sense of colour, so that the muscular element enters into the conception of something seen.

In my experience there were far fewer blind than deaf insane persons and they were always more cheerful and more amenable to discipline. They were rarely hostile to their environment and were without the suspicion so often characteristic of the deaf person.

The rods and cones are the *receptors* for sight. The cones in the yellow spot give the area of clearest vision, the rods are outside; both are present intermedially, and their functions were seen in some of the mental cases. The *cones* are specialised for colour, whereas the *rods* represent the primitive sight, sensitive to dim light, and in daylight sight is excited through the *cones*, the rods being exhausted in bright light and taking time to recover. Some of the psychasthenic cases often refused to go out to chapel and to entertainments at night because they could not see, they said, which was in accordance with the physiological fact that on going out into the dark or into twilight the *rods,* which were exhausted, could not see light, and the cones only gave colour. The rods give no

colour information, and in *twilight* (when there is not enough light to stimulate the cones that give colour sensation) the warm tones fade, cold blues and greys remain, and the scarlet poppies appear black; only the lights of low intensity remain, such as yellow, green and blue.

The birds that do not see at night have *no rods*, and the dim light is not enough to stimulate the cones. It is thus that pheasants are so easily stolen; they do not see their captors, and only move when they are touched—too late to escape.

Colour has been used therapeutically for the relief of psychasthenia and some mental disorders and colour has always symbolically represented the emotions—jealousy = green, red = anger, dimness = religious light of a cathedral. The poets draped melancholy in violet garments and the church drapes the sacred symbols in violet at the appropriate seasons. The violet light is said to calm *the nerves* of the excited. In 1896 Claybury established a series of decorated rooms in colour; the windows were glazed with red glass in one and in another with blue, with the object of raising the spirits of the depressed in the red rooms and calming the morbidly excited in the violet ones. The failures were more numerous than the successes and the *neutral* list was a long one, but it is always very difficult to appraise moral factors, and suggestion plays a great part in nervous diseases. At the Maudsley Hospital the attempt was made to influence some cases of mental and nervous disorders by the help of colours, mainly yellow, blue and green, the former as a stimulant and the latter as a sedative, and the matron reported less "crime," *i. e.* minor delinquencies in the blue and green rooms than in the others where no colour was used.

Dr. S. A. Kinnier Wilson:

Psychological peculiarities in certain visual auras in epilepsy.

In the course of out-patient work at the National Hospital I have met with a very large number of cases

of idiopathic epilepsy, among which is a definite group distinguished by a mental state which presents curious psychological characteristics of its own. To this group attention was directed by Hughlings Jackson on a number of occasions. The aura he described as associated with a "dreamy state," a "voluminous mental state," a "feeling of having been there before," "double consciousness," a "feeling of being somewhere else," "reminiscence," a "feeling of unreality." Sometimes the feeling is so peculiar and so rapid that the patient cannot really find words for it; it has been described as a "return to youth," "the recurrence of an old dream," "a loss of the perception of external objects or of one's own corporeality."

To those who are unfamiliar with the facts all this may appear elusive if not actually intangible; nevertheless when the phenomena occur in an ordinary well-developed form they are so striking and so definite as at once to arrest attention.

No attempt has as yet been made to classify these "voluminous mental states," and yet among them are to be found two distinct types, as I consider, which may be of some interest to the ophthalmologist.

These are what I think may be called (1) the "déjà vu" or "familiarity" type, and its reverse, the "strangeness," "unfamiliarity" or "unreality" type, and (2) the "visual memory" type. It must be clearly understood that these are to be distinguished altogether from the group of special sense auræ, the hallucinatory type, which were admirably described by the late Sir William Gowers in a Bowman lecture. Associated with them, it is true, are subjective or hallucinatory phenomena in the sensory sphere of taste and smell, the whole constituting what is known as the uncinate variety of epilepsy; but for the purpose of this brief communication these latter phenomena may be left on one side, and attention concentrated on the peculiarities of the aura and the mental state as far as its visual aspect is concerned.

One or two illustrations will serve to make clear the kind of case that we are considering.

Type I: (*a*) The "déjà vu" or "familiarity" type:

Case 1.—W. J—, male, æt. 38 years. Idiopathic epileptic. Has the following aura to his fits: "It seems to take me to a set of circumstances in which I have found myself before, or to a place where I have been before. I feel that I see things happening as they have happened before, or that people are coming together as before. I never can identify it, however. At the same time I know where I actually am." Immediately after he loses consciousness.

Case 2.—E. B—, female, æt. 23 years, has suffered from fits since the age of fifteen. Aura: "I feel as if I were in a dream, or half asleep, though I know exactly where I am and what is around me. I always feel as if I had been having a conversation with some one and they with me; the voices are familiar, but I never can quite remember whose they are or what they have been saying. I once went to Kew Gardens. I had never been there before. One of the attacks was coming on just as I went in. I felt at once that I had been there before; it was quite familiar. It made me feel quite miserable, and tears came into my eyes."

(*b*) The "unfamiliarity" or "unreality" type:

Case 3.—E. N—, female, æt. 32 years, has a wretched family history of epilepsy. She describes the aura of her attacks as follows: "I am feeling well and happy. All of a sudden everything round me seems strange and different. I think it funny I should feel like that, because I know I am so well. I've been at the table talking to people and I've said to myself, I know you, and you, and you, and at the same time they have been unreal and different. They have never noticed anything and yet the feeling has been there. Then I suddenly feel something dreadful is going to happen."

Types (*a*) and (*b*) are more or less combined in the following case:

Case 4.—E. C—, female, æt. 23 years, has suffered from fits for three years. The aura is thus particularised: "I feel I am a different person from my own self, and that I am in a different place from the one in which I actually am. In the attacks I know exactly where I am, nevertheless. The feeling is so confusing. In them I have the feeling that the thing I am doing I have done before." Again: "At mid-day I was standing talking to my mother and sister. Suddenly something that my mother said kept echoing in my brain and I felt she was saying something she had said before, and everything looked the same as it had been before at some previous time." Again: "I was writing out cheques in the laundry office; then came a most peculiar feeling of great familiarity with what I was doing; a feeling of intensified familiarity; a feeling it had all happened before." The patient also said: "When I say that in the attack the things around me are different, not real, I mean I see them perfectly well, but they feel different, and feel as I imagine they might feel when being looked at by another person. I feel as if they were giving me the impression they might give to someone else." Once more: "I feel I have had a previous existence, and that in these sensations I step out of myself into the other existence. The things round me do not seem real; I feel that I do not belong to the room. I feel as if my brain were leaving my body for the moment. At one time I used rather to welcome it as a not unpleasant feeling."

II: The "visual memory" type:

Case 5.—T. G—, male, æt. 54 years, has suffered from fits for seven years. The state is thus described: "I seem to wander back many years of my life to things that happened when I was an absolute child. Trifling things, childish things, come back to me, and I wonder how it is I could remember them. Sometimes I am back many years to some event in my life when I should have done so-and-so, and I didn't. It is like a vision. It seems as if I had gone right back and become part of the scene

again; I am awake, and yet I seem to be dreaming old things over again."

Case 6.—C. W—, female, æt. 35 years, has a miserable family history of epilepsy and insanity. Her aura is as follows: "I go into a curious state in which I suddenly remember all sorts of things that happened when I was a child. They are stupid, old-fashioned things of my childhood. They are things that I have done in days gone by, in other places. I see round me things and places that I used to know. I remember silly things like swinging, playing with toys with other girls, and then I go off."

However elaborate the dreamy state, however complex its visuo-psychic phenomena, we must bear in mind the fact that in combination with the taste and smell hallucinations (in this place left out of account) it bears a most definite relation to typical generalised epileptic seizures; it occurs as a part of an epileptic attack. It is an index of the commencement of a cerebral disturbance which ends by crude convulsions, and is as deserving of investigation as is an aura of tingling in the great toe.

I. We may take together the "familiarity" and "unfamiliarity" or "unreality" varieties, since one is as it were the reverse of the other.

The phenomenon of "déjà vu" (paramnesia, "fausse reconnaissance") is of common occurrence in normal individuals, as we all know. It is the feeling (not so much a "feeling" as a "judgment") of the particular set of circumstances in which one finds oneself at the moment having occurred before or having been experienced before, and is capable of a number of widely differing explanations.

A. (1) The reminiscence may be a genuine one of waking life. Actual past events, dimly remembered, their details forgotten or only partially recovered, may induce the belief that the new state is a repetition, and this explanation is in my view sufficient for a large number of simple cases. A friend of mine remarked

spontaneously that she most frequently experiences the sensation of "déjà vu" when wandering through a ruined castle where she has never really been before. Now one ruined castle, with its broken staircases, its silent courtyard, its vaults, its dungeons, is certainly just like any other, so that the paramnesia in such instances has its basis in ill-remembered actual previous states.

(2) The previous events on which the pseudo-memory is based may be genuine, but unknown to the individual, *i. e.* they may be buried in his unconscious mind, as in a case reported by Abercrombie.

(3) The previous event may be not a genuine experience of the waking life, but a figment of the waking imagination. The "déjà vu" phenomenon may arise from the products of mental activity we call day-dreams, fantasies, reveries. I have found an admirable example of this explanation in Knight's book, *Where Three Empires Meet*. Freud has alluded to the matter in his most popular book, and selects the unconscious fantasy explanation, to the exclusion of all others: "Something is really touched that we have already experienced, only we cannot consciously recall the latter because it never was conscious." He works the unconscious fantasy round to a repressed wish, but the illustration he gives is distinctly unconvincing.

(4) The reminiscence may have its origin in dream-consciousness. Under certain conditions the difficulty of differentiating what has been really experienced from what has merely been dreamed is considerable.

(5) Both Sully and F. W. H. Myers linger over the possibility, and scarcely conceal their fascination by it, of the hereditary transmission of psychical phenomena—the instantaneous emotions of the mother imprinting themselves as memories on the fœtal cortex. "If it were found that a child that was descended from a line of seafaring ancestors, and that had never itself seen or heard of the dark-gleaming sea, manifested a feeling of recognition when first beholding it, we might be pretty sure that such a thing as recollection of prenatal events

does take place." Freud's *Traumdeutung*, too, contains several instances of dreams which he chooses to interpret as based on unconscious antenatal impressions. Shadowy recollections will not, however, be made clearer by equally shadowy speculations.

B. In the second place, however, the reminiscence may be purely illusory, in the sense that no previous conscious or unconscious experience may underlie it; it may result from a disorder of perception or recognition processes. Freud dismisses such explanation without comment, yet his own view does not serve for such chronic cases of the condition as have been described by Pick, Coriat and others under the heading of "reduplicative paramnesia." Coriat's cases included chronic alcoholism, general paralysis and senile dementia. I have seen two excellent examples of reduplicative paramnesia in epileptic confusional states and in general paralysis. In this state, whatever the patient does, wherever he is, whomsoever he meets, he has a constant feeling that he has received the same impressions before, has done or said, or seen, the same thing before. To explain each and every perpetually recurring instance in these cases as being due to an unconscious fantasy seems to me an impossiblity.

C. Leaving aside, without more than mentioning, the psychological solutions offered by Lewes, Lalande, Ribot and others, I may simply say that the view which commends itself to my mind takes cognisance of the occasional occurrence of a separate "familiarity-quality" or "recognition-feeling" (Bekanntheitsqualität, Bekanntheitsgefühl) as a psychical phenomenon attending perception. This "familiarity-quality" transforms perception into recognition erroneously. Now in the cases of epilepsy here referred to we have seen that the phenomenon of "déjà vu" is of not infrequent occurrence in the first stage of an attack; and the suggested explanation is that the "familiarity-quality" is, as it were, added to the perception of some object or scene or event—hence the feeling of "déjà vu." On the other hand, it may at the same time

be removed from the recognition of the familiar objects around, so that the patient's environment at once appears unreal, strange, different, "funny." From the patients themselves one has been able to gather that before consciousness is lost the sufferer often finds himself in a curious "double" mental state; he knows where he is, and at the same time he feels as if he were somewhere else; the familiar objects round him become unfamiliar, while the unfamiliar scene in which he seems to be becomes familiar.

When what occurs in normal individuals is also encountered in the early stage of epileptic seizures we might suppose, with Hughlings Jackson, that the elaborate mental state is arising during the activity of centres which are healthy except for loss of control. The suggestion is that the phenomenon is a form of release-phenomenon, whether it takes place in normal or abnormal persons. In Jackson's words, "the state is not the result of epileptic discharge of the highest centres, but is owing to over-activity of the next lower centres, as yet untouched by the discharge." If this were the whole explanation, it seems to me we should expect the phenomenon in practically every example of epilepsy, which is far from being the case. The peculiar fact of the added element of familiarity is not accounted for simply by release (or, if it is, we must emphasise its special likelihood to occur in cases where we believe the discharges start in the temporal lobes). Janet considers the phenomenon of "déjà vu," in its reverse form of unreality or strangeness, to be due to a diminution of psychological tension; when the mind is accustomed to a certain maximum of consciousness, that maximum constitutes reality for the individual, and when it is not attained the mind no longer has a feeling of the present and of reality. If this be accepted, then "déjà vu" is an over-reality feeling, and again requires further explanation than can be given on the ground that it is a mere "release."

II. As for the second type of aura specified above, viz. the "visual-memory" variety, its occurrence has been

noted in pathological conditions other than epilepsy. Most people are aware that there are on record well-authenticated instances of unconsciousness from drowning, death all but supervening, in which the individual concerned, so far from suffering agonies, has in a few seconds of time lived over again events of his past life as one panoramic picture succeeds another. It is not so well known, however, that the same curious experience has been remarked in cases of hanging, a striking example being recorded by Forbes Winslow. A personal friend of my own has told me how he, too, during the half-minute of unconsciousness that supervened on his choking over a piece of meat lodging in his throat, saw before him an astonishing series of childhood scenes—the furniture of his nursery, its wall-paper and carpet, his nurse's face, etc.—and how surprised he afterwards was to think that all these early visual memories could thus rise again in the clearest of outlines.

In the early days of the war a letter by an officer describing a retreat under fire was published in the columns of the *Times*, from which I take the following excerpt:

"We lay there in the potato crop like partridges. I think we were all too petrified to move. We lay under that shell-fire for three hours, and I think that none of us will ever forget the feeling of thinking that the next moment we might be dead. I kept wondering what it was going to feel like to be dead, and all sorts of little things that I had done and places I had been to years ago and had quite forgotten kept passing through my mind. I have often heard of this happening to a drowning man, but have never experienced it before and don't want to again! . . . My brain seemed extraordinarily cool and collected, but I looked at my hands and saw them moving and twisting in an extraordinary way, as if they didn't belong to me," etc.

Here, then, is the definite resuscitation of an apparently unending series of mental pictures back to infancy, released during partial asphyxiation from drowning, hanging, or choking, or in a state of extreme emotion

sufficiently intense to overwhelm cortical control, and we have seen precisely the same phenomenon arise as part of an epileptic fit.

It seems a legitimate deduction that the complex "memory" aura, more definitely than the "familiarity" one, is a release-phenomenon, that abeyance of normal consciousness allows formerly organised mental states to rise into a secondary consciousness, hence the so-called "double consciousness" of which the patients themselves not infrequently make note, and which, as already mentioned, may in another form take the shape of "being" in one place and "feeling" in another. The neurologist is well aware that organic lesions of the temporo-sphenoidal lobe, in particular of the uncinate region, are calculated to give rise to the special combination of crude hallucinations of taste or smell, and the "dreamy state," one of the features of which may be the "memory" aura. It is suggested that the physiological basis of the latter phenomenon is a stimulation of the visuo-psychic areas from the temporal lobe by means of the important association path known as the inferior longitudinal fasciculus, which joins temporal and occipito-parietal regions. In normal health it is a common experience that a scent or odour arouses a visual picture or a series of pictures, often dating back years in the individual's life, and it can be, in my view, no mere coincidence that the elaborate psychical states of which the merest sketch has here been given should be so frequently associated, as a clinical fact, with hallucinations of an olfactory or gustatory order. Yet I should not wish to be taken as attempting to "localise" the physiological substratum of the "déjà vu" phenomenon in the vast largely uncharted cortex of the temporal lobes; at the most one may say that when in idiopathic epilepsy the discharges involve the neural elements of the temporo-sphenoidal lobes a peculiar mental state is particularly apt to develop; it may take, *inter alia*, either the "familiarity-unfamiliarity" form, or the "visual memory"

form: the latter results from excitation spreading to physiologically related centres, while the former has a special psychological quality of its own, not to be localised on the physiological level.

Mr. A. S. Percival:

When the mind refers its sensations to an external object as their cause, certain physical stimuli reach sense-organs, set up neural changes, which are accompanied by psychological changes, *i. e.* by sensation and by perception.

It is well to realise first that a sensory impulse may not affect consciousness, and yet a co-ordinated movement in response to that stimulus may result. When reading I may knock my knee against the table-leg, and at once rub my knee with one hand, although if I am sufficiently interested in what I am reading I may be entirely unconscious of any pain in my knee or of my rubbing it. We are all familiar with various kinds of reflex actions, that learning to ride a bicycle or to drive a motor-car is mainly forming or growing a direct commissural tract between a receptive centre and the appropriate motor centre—at least that is, I believe, what physiologists teach us. A banking-clerk does not think in order to add; indeed, mathematicians think strenuously before attacking a problem, but when they have decided on the shortest and simplest way they arrive at their result by a sort of reflex act of computation, and the less they think the less likely are they to make mistakes.

Again, one may imagine that one sees a table or a person at will—the physico-psychical apparatus seems to be a perfect or reversible engine—and I am inclined to think that most probably when one imagines a blackboard the mind excites a sensory impression in the higher visual centres, which passes down the usual path associated with such impressions, and eventually excites the corresponding parts of both retinæ. The retina is only an outlying vesicle of the brain, and the optic nerve is a commissure

which presumably can carry impulses either way; at any rate, this makes the fact that an optic nerve can degenerate both upwards and downwards more intelligible. Of course the pure histologist is quite satisfied with his observation that the optic nerve has no nodes of Ranvier, but why has it none? It surely may be because it is purely a commissural tract, and has the special functions of a commissure that it can conduct impulses both ways. This is only a speculation of mine, and in order that a conception may have scientific validity it must be self-consistent and deductible from the perceptions of the normal human being. A scientifically valid inference is that which *could* be drawn by every logically trained normal mind—not *would* be drawn—for many minds have too much inertia, too much bias or prejudice to think at all in novel lines. With all humility I submit this speculation to you to judge me guilty, if it appears so to you, of my prejudice in favour of my conception. Now I take it that the psychology of vision really means an inquiry as to how a physical or chemical change in certain nerve-cells can give rise to a consciousness of the sensation of light. Surely the most primitive, the simplest visual sensation is that of light: a response to light is seen in the vegetable world, in the invertebrate by a movement of the organism or a part of it. In another place I have given nearly all I have learnt about light-sense in man, and to me the most promising path to try in this seemingly impenetrable forest appears to be a mathematical one based on certain electrical analogies.

The main object of all mathematical analysis is to discover what is general in a specific instance, and a differential equation is the shortest and most general way of stating a general law. It is not the simplest, but it will lead to the fewest mistakes. Practically all elementary mechanics and a great part of astronomy is hidden in the innocent-looking expression, $\frac{d^2y}{dt^2} = o$, but it often requires prolonged and strenuous thought to

interpret—to see all the meaning of a differential equation. I have been warned off mathematics by our secretary, and I am not going to wander in that enticing woodland again.

Before we venture to explore that unknown region between mind and matter it is well to survey carefully the better-known physiological land that we are leaving. Now there is one point at which I am convinced that physiologists have strayed from their want of familiarity with well-known physical facts. Allow me to speak for a moment on the subject of tremors; it will be found, I think, to throw a flood of light upon some most puzzling ophthalmic phenomena.

We know that in a pure peripheral neuritis a frequent if not invariable symptom is that of tremor of the affected limb. It seems curious that if the cortical centres are acting normally, an alteration in the conducting fibres should be associated with intermittent nervous impulses. An electrician would at once see a striking analogy in the discharge of a Leyden jar. If it is discharged through a conductor of high resistance, such as a nearly dry linen thread, the discharge is all in one direction, and rapidly dies away. If, however, the discharge takes place through a conductor of low resistance, the discharge consists of a number of excessively rapid oscillations or surgings. Indeed an electric spark, or a flash of lightning, which seems to be instantaneous, and lasts only a ten-thousandth of a second or less, is found to consist of a number of oscillating discharges. The oscillations can be made slower by increasing the capacity (we may roughly say the size) of the Leyden jar, and by increasing the self-induction of the conducting wire (*e. g.* by bending it into a number of coils). If the resistance of the wire is sufficiently increased there will be no oscillations at all.

Now in peripheral neuritis histologists tell us that the medullary sheaths break up, and so previously insulated axis cylinders come in contact, thus opening up many different new paths for the nervous current. If the Leyden jar be coupled up with several miles of Atlantic

cable, one fibre of which is connected with the outer coating of the jar, the resistance will be so great that the discharge will be aperiodic, but if the insulation in the cable is all broken down the resistance will be very much less, and the discharge will be periodic or oscillatory. Just so I take it that when the musculo-spiral is affected with a traumatic neuritis an oscillatory discharge of the nervous current occurs and tremors result.

Now in optic neuritis presumably the afferent impulses are oscillatory, and this throws light on the curious fact that in optic-nerve lesions the estimation of light difference is much more affected than that of the light minimum. It was found by the late Dr. Doyne that in retrobulbar neuritis the latent period of the pupillary reaction to light was diminished from 0·4 to 0·3 second. Also in most cases of monocular retrobulbar neuritis we find that the pupillary reaction is oscillatory or much more oscillatory than that in the sound eye. There is, of course, one striking difference between the nervous and the electrical analogy—that of time. The oscillatory tremors are about 3 or 4 a second; indeed, the normal tetanic contraction occurs when the frequency is from 12 to 19 a second, but I am convinced that the general law expressed by the differential equation, which I will not trouble you with, applies to nerve-currents as well as electrical currents. Much research work would be required to elaborate this suggestion; it is possible that what is called "irradiation" may be analogous to self-induction.

In conclusion, I must thank you for so patiently listening while I have only been skirting round the borderland of physiology, and have never touched psychology, our real subject.

Mr. Frank Juler:

Amblyopia from disuse. Visual acuity after traumatic cataract in children.

In considering the question of amblyopia from disuse it seemed to me that one wanted to throw light upon it by

evidence which gave more exact determination of dates of onset than is obtained from ordinary strabismus cases. The date of onset of strabismus is always impossible to verify; the statement of parents or friends is usually the only factor at one's disposal. The other causes with which amblyopia *ex* anopsia is said to be associated, namely, opacities in the clear media of the eye, are most commonly more or less permanent. I thought that in certain cases of injury to the lens in young children we might obtain a possible line of evidence which, positive or negative, would satisfy the disputators, and perhaps decide one way or another the question as to whether amblyopia from disuse exists or not.

In most cases of traumatic cataract, the opacity is rapid, and little light reaches the retina after the date of the injury. In some of my cases the lens matter had been evacuated soon afterwards, leaving only an opaque membrane, whilst in a few an artificial pupil was made not much later. Even in cases where an artificial pupil has been made, the diffusion of images by the aphakic hypermetropia must be so great that the retinal impulses cannot compete with nor assist those transmitted from the retina of the sound eye, and one would expect these impulses to be neglected, with the consequent development of amblyopia from disuse, if such a disease exists: the latter should still more certainly develop if an opaque lens or membrane blocks the light path for some considerable period of time.

With this end in view I have searched the in-patient notes at Moorfields Hospital for the years 1910–1917, and by the permission of my colleagues I have been able to trace a certain number of juvenile traumatic cataracts, to see them personally, in many cases to form a new pupil, and finally myself to examine the vision, fundus and other points in every case quoted.

The list of cases I am bringing before you to-day is the residuum which fulfilled certain conditions, namely, at the final examination of the injured eye, which is made

some years after the accident, there must be no gross lesion of the globe beyond aphakia; corneal scars must not be so large as seriously to interfere with vision; the iris must not be severely damaged; a clear gap in the pupil must be present and allow of a detailed examination of the fundus and vitreous, which must be found normal; the child must be old enough to read test-types with facility. Particular care has been taken to ascertain the dates of birth in each case, and in all the cases seen at Moorfields the dates of injury, operations and final condition have been accurately obtained from the in-patient and out-patient notes.

In considering the visual results which I have obtained one may perhaps count $\frac{6}{12}$ vision or even $\frac{6}{12}$ partly as normal, as there is in many cases a definite corneal scar present which may cause interference with the retinal image by dispersion of light. At any rate this is the standard I have mentally adopted in considering the tabulated results. In the table shown (p. 132) I have collected the main details of each case together, and arranged the cases in order according to the age at which the injury occurred. At the end of the paper are further details of each case.

It will be seen that there is a striking line of difference between the final visual results depending on the age at which the injury occurred, or rather the age at which the lens became opaque (for in two cases at least the cataract was a late development). None of those eyes which became cataractous before the age of five have retained a final central acuity of vision of $\frac{6}{60}$. Cases 1 and 2 cannot count fingers; Cases 3, 4 and 5 count fingers at about 1 metre distant. Cases 6 and 7 were injured about their sixth birthday and finally read $\frac{6}{60}$ and one letter of $\frac{6}{36}$. Case 8 with injury at 6 years and 2 months can but count fingers at $\frac{1}{2}$ metre. Cases 9 to 18 injured at 6 years and 10 months or older have in every case shown an acuity of $\frac{6}{12}$ (partly) or better. Of interest in this group are numbers 15 and 17. Case 15

Traumatic Cataract.

Case No.	Age at time of injury.	Age at final report.	Visual result with glasses.	Remarks.
1	1 $\frac{6}{12}$	11	Hand-movements	? Concussion cataract. Convergent. No power of fixation.
2	4 $\frac{6}{12}$	10 $\frac{5}{12}$	Hand-movements	Convergent.
3	4 $\frac{5}{12}$	8 $\frac{5}{12}$	Fingers at 1 metre	Anterior synechia of capsule.
4	4 $\frac{5}{12}$	11 $\frac{5}{12}$	Fingers at 1½ metres	No power of fixation.
5	4 $\frac{10}{12}$	9 $\frac{5}{12}$	Fingers at ½ metre	Convergent.
6	5 $\frac{11}{12}$	10 $\frac{5}{12}$	$\frac{6}{36}$ (1 letter)	Steady fixation.
7	6	10	$\frac{6}{36}$ (1 letter)	Slight divergence, steady fixation.
8	6 $\frac{2}{12}$	14	Fingers at ½ metre	No power of fixation, slight convergence.
9	6 $\frac{10}{12}$	12 $\frac{4}{12}$	$\frac{6}{12}$ partly	Convergence with malprojection.
10	7 $\frac{7}{12}$	11 $\frac{1}{12}$	$\frac{6}{12}$ (3 L.)	—
11	7 $\frac{9}{12}$	11 $\frac{11}{12}$	$\frac{6}{12}$	Divergent.
12	7 $\frac{11}{12}$	11 $\frac{7}{12}$	$\frac{6}{9}$ (part)	Divergent with malprojection.
13	8 $\frac{6}{12}$	12 $\frac{5}{12}$	$\frac{6}{12}$ (3 L.)	—
14	8 $\frac{9}{12}$	17 $\frac{5}{12}$	$\frac{6}{12}$ (partly)	Divergent with malprojection.
15	10	44	$\frac{6}{6}$	Divergence with malprojection.
16	11 $\frac{1}{12}$	15 $\frac{8}{12}$	$\frac{6}{12}$ (3 L.)	—
17	13	18	$\frac{6}{6}$ (partly)	Gradual failure up to 6 months after injury. Crystals in retina and media. (Pl. I, fig. 1.)
18	14 $\frac{10}{12}$	16 $\frac{1}{12}$	$\frac{6}{12}$ (partly)	—
		Doubtful Cases.		
19	5 $\frac{9}{12}$	13 $\frac{4}{12}$	Hand-movements	Convergent. Small gap in pupil. Fundus normal as far as visible, but details of macula not obtained.
20	6 $\frac{1}{12}$?	10 $\frac{11}{12}$	$\frac{6}{12}$ (2 letters)	Gradual failure of vision after injury, probably late development of cataract.
21	? 9, date uncertain	20	$\frac{6}{6}$	Slight convergence.
22	Unilateral congenital cataract	7 $\frac{5}{12}$	Fixation defective	Convergent.

had $\frac{6}{6}$ vision thirty-four years after the injury; Case 17 shows a brilliant display of crystals throughout the globe. (See p. 138 and Pl. I, fig. 1.)

Included in the above are *all* of the cases which fulfilled the conditions enumerated previously. I much regret that more cases with injury before the age of six years have not been seen, for the number of these is too small to be completely convincing. In three or four others who were under six years of age one could not be quite certain of the fundus, and in all these vision was very defective, though tiny gaps in the capsule were present.

Amongst those marked "doubtful cases" are a few which nearly fulfilled all the conditions laid down. In Case 19 with injury at 5 years and 9 months the gap in the capsule is too small to allow of a complete examination of the fundus, there is certainly no gross change present, and I think it might rank as evidence; the vision is very defective, being hand-movements only. Case 20 was not seen at Moorfields and the early notes are defective; one had to rely on the parents' statements, and their remarks were not convincing. They were not quite sure of the year of the child's birth; he was probably just six at the time of injury, but may have been just seven years. The cataract seems to have developed gradually as nothing was noted amiss until six months later, when the school teacher discovered a defect. Case 21 was a patient at a Midland town for the original injury, but the surgeon who had charge was unable to supply me with any information. She thinks she was about 9 at the time, but her parents are dead and she cannot give any certain evidence. The eye can now only see $\frac{3}{60}$, but I doubt whether it should be allowed to count against conclusions deduced from the preceding notes. Case 22 was the only case I have examined which had undergone operation for unilateral congenital cataract: the vision remains extremely defective.

As far as it goes this series of cases gives evidence

that there is such a disease as amblyopia from disuse, that it affects the eyes of children up to the age of six years, that it does not attack eyes after the age of seven years, that it is not merely a standing still of the development of the retina or certain cerebral associations, but that it causes a real retrogression of the effective power of the retinal impulse on the consciousness, after the macula has reached an age at which central vision of $\frac{6}{6}$ is normally present.

The existence of amblyopia from disuse as the result of concomitant squint has been a subject of dispute amongst ophthalmic surgeons for the last fifty years. An examination of its very copious literature reveals a diversity of opinions for and against.

Rogman* in 1901, reviewing the bibliography, found that the majority of surgeons admit its presence; in this group were the names of Panas, Fuchs, Leber, Vossius, Schmidt-Rimpler, Knies, Meyer, Javal, Goldzieher, Hoor, Sachs, Schnabel and Klein. Amongst those who stoutly denied such an entity were Schweigger, Alfred Graefe and Silex.

In recent literature Fuchs agrees that accepted views are very divergent on the subject, many holding that there is really no such thing, but that it refers to a congenital condition which is the cause and not the result of a strabismus. "On the whole, however," he writes, "the testimony seems in favour of the view enunciated" (*i. e.* that there is a true amblyopia from disuse).†

Werner‡ discusses the question at some length, and leaves the subject undecided.

Parsons is not altogether satisfied with the view held by many that the defective vision is due to the prolonged suppression of the images derived from the eye in question.§

Worth is whole-heartedly in favour of amblyopia *ex*

* Rogman, *Annales d'Ocul.*, cxxvi, p. 175.

† Fuchs, *Text book of Ophthalmology* (Duane), fifth edition, 1913, p. 765.

‡ Swanzy's *Diseases of the Eye*, twelfth edition, 1919, p. 533.

§ Parsons, *Diseases of the Eye*, third edition, 1918, p. 533.

anopsia, and considers it due to a mental suppression of the retinal image with rapid deterioration of vision. The earlier the onset of strabismus, the higher the degree of amblyopia. It seldom occurs after six years of age. (As will be seen from my table, this statement agrees very well with my results.*)

Webster Fox concurs in the entity in squints, but considers that in some types amblyopia is present at birth.†

Whether the actual proof of amblyopia from disuse can be held to determine the cause of amblyopia in strabismus is a matter for further consideration, but such a demonstration must strengthen the probability of identity between the two.

In making these investigations a few other points have come out, which may be worth mentioning.

(1) *Strabismus* secondary to loss of vision. In 13 out of the 22 cases strabismus was present, and had occurred subsequent to the injury; in 8 cases a convergence, in 5 a divergence. In nearly all the unaffected eye had apparently normal refraction, though beyond a vision test this point was not especially looked for. No vertical squint was noted.

(2) *Malprojection.*—Some of these patients with squint, but with retention of vision, were roughly tested for malprojection, and this was easily demonstrated when the strabismus was marked. Cases of convergence projected objects to the temporal side, cases of divergence to the nasal side, *i. e.* in the same direction as in paralyses of the external and internal recti respectively.

This observation may be of value in the explanation of mal-projection, as indicating that it is due to a wrong orientation of objects, owing to an altered muscle-sense.

(3) *Fixation.*—The power of steady fixation is present in eyes which have a central acuity of $\frac{6}{60}$ or better; where

* C. Worth, *Squint*, 1915, London, p. 65.

† Webster Fox, *A Practical Treatise on Ophthalmology*, New York and London, 1920, pp. 384 and 696.

vision is reduced to less than this, that power is lost. This agrees with statements made by Worth.

(4) One case examined (not mentioned in the table or list of cases) showed a marked degree of *buphthalmos*, obviously secondary to the extensive corneal scar, with adherent iris and capsule.

Cases.

Case 1.—Gladys S— (Royal London Ophthalmic Hospital, Mr. E. T. Collins). Struck left side of head 29 . xi . '10; greyness of pupil noticed one week later; attended 12 . xii . '10. Æt. $1\frac{9}{12}$ years. Left lens opaque, pupil active. ? Concussion cataract. 5 . i . '11: L. needling. 30 . i . '11: Much lens matter in pupil. 31 . v . '17: L. convergent. V. = P.L., projection good. L. needling. 4 . vi . '17: Small gap, vision not improved. 3 . ix . '19: R.V. s. + 2 cyl. + 1·5 = ⅔ partly.

Final note: 24 . iii . '20, æt. 11 years. V.L. s. + 9 = hand movements, visual field nearly full to rough test. Convergence about 20°, fixation not present. Good gap in capsule; fundus well seen; the disc is perhaps a little pale, and cupped on the temporal side, but the right disc shows a similar appearance. There are some white striæ in the left retina up and in, but otherwise the fundus is normal and the vitreous clear. T.n.

Case 2.—Kathleen D— (R.L.O.H., Mr. Marshall). On 11 . vi . '14, at age of $4\frac{6}{12}$ years, R. injured by a pin. 13 . vi . '14: R. lens opaque, soft matter in A.C. 3. vii . '14: R. curette evacuation. 10 . vii . '14: Division of anterior synechia of capsule. 15 . vii . '14: Pupil blocked by capsule. T.n. 16 . x . '14: R. needling. 11 . xi . '14: Clear gap. Internal strabismus.

Final note: 8 . ix . '20, æt. $10\frac{8}{12}$ years. R. convergence, two small linear scars in centre of cornea, pupil nearly circular, clear gap in capsule, fundus normal. R.V. s. + 9 = hand-movements only, fixation not present. L.V. $\frac{6}{6}$, H.m. + 1 D.

Case 3.—Winnie F— (R.L.O.H., Mr. Lawford). On 9 . vii . '16, at age of $4\frac{8}{12}$ years, L. injured by scissors; admitted with central wound of cornea and cataract. 19 . vii . '16: Evacuation of lens matter. 2 . viii . '16: Capsule to scar, lens matter below. 7 . i . '20: Division anterior synechia, which was repeated on 17 . i . '20. 21 . iv . '20: Left division of anterior synechia and needling.

Final note: 8 . v . '20, æt. $8\frac{7}{12}$ years. L. quiet, still pigmented strand of capsule to scar, iris free, small gap in capsule. Fundus normal, L.V. s. + 14 = fingers at 1 m. Visual axes parallel.

Case 4.—Charlie W— (R.L.O.H., Mr. Fisher). On 20 . vi . '13, at age of $4\frac{9}{12}$ years R. injured by needle. On 25 . vi . '13, small punctured wound of cornea, anterior synechia, lens opaque. 29 . vii . '13: R. division of synechia and needling. 23 . ix . '13: Needling. 30 . ix . '13: Curette evacuation and lavage of A.C. 15 . x . '13: Much soft lens matter still present. T.n. 22 . v . '14: Clear gap in pupil.

Final note: 24 . iii . '20, æt. $11\frac{5}{12}$ years. L.V. = $\frac{6}{6}$; R.V. s. + 9, counts fingers at $1\frac{1}{2}$ m. Power of fixation not present, no strabismus. Good gap present in capsule, fundus normal. Small anterior synechia of capsule.

Case 5: Tom B— (R.L.O.H., Mr. Worth). At age of $4\frac{10}{12}$ years injured R. on 15 . ix . '15. Perforation of R. cornea, abscission of prolapsed iris. 8 . x . '15: Lens opaque. 25 . x . '15: Curette evacuation. 2 . xii . '15: R. needling and division of capsular synechia. 10 . xii . '15: Gap in capsule. 15 . v . 20: R. converges, needled.

Final note: 17 . vii . '20, æt. $9\frac{8}{12}$ years. L.V. $\frac{6}{9}$; R.V. s. + 10 = fingers at $\frac{1}{2}$ m. R. iris coloboma outwards, central gap in capsule, fundus normal.

Case 6.—Frank K— (R.L.O.H., Mr. Hepburn). At age of $5\frac{11}{12}$ years, on 30 . x . '15, L. injured by an arrow. 2 . xi . '15: Wound of cornea, lens partly opaque, abscission of iris prolapse. 4 . xi . '15: Iridectomy, 19 . xi . '15: Division of synechia. 22 . xi . '15: Lens partly opaque, some red reflex present. 28 . vi . '16: Dense capsule needled. 3 . vii . '16: Good central gap.

Final note: 7 . iv . '20, æt. $10\frac{6}{12}$ years. V.R. s. + 3 cyl. + 3 = $\frac{6}{9}$; V.L. s. + 13 = $\frac{6}{36}$ (1 L.). L. iris coloboma upwards, clear gap in capsule, fundus normal, power of fixation present.

Case 7.—Fred S— (R.L.O.H., Mr. Fisher). At age of 6 years, on 29 . iii . '16, L. injured by hatpin. 18 . iv . 16: L. corneal wound, lens opaque, needled. 1 . v . '16: Needling. 4 . vii . '16: Needling. 10 . vii . '16: Good gap. T.n.

Final note: 27 . iii . '20: æt. 10 years. R.V. cyl. − 1·25 = $\frac{6}{9}$ part; L.V. s. + 10 cyl. + 1 = $\frac{6}{36}$ (1 L). L. diverges slightly, can fix, good gap in capsule, fundus normal.

Case 8.—Sidney N— (R.L.O.H., Mr. Coats). At age of $6\frac{2}{12}$ years, on 25 . v . '12, R. injured by a dart. 5 . vi . '12: Small corneal wound, lens matter in pupil. 13 . ix . '12: Lens matter nearly absorbed, no gap in capsule. 17 . iii . '20: Dense membrane in pupil, needled.

Final note: 20 . iii . '20, æt. 14 years. L.V. = $\frac{6}{6}$; R.V. s. + 10 = fingers at $\frac{1}{2}$ m. R. slight convergence; no power of fixation. Good gap in capsule; fundus normal; visual field full to rough test.

Case 9.—Arthur D— (R.L.O.H., Mr. Lawford). At age of $6\frac{10}{12}$ years, on 29 . vii . '14, R. struck by branch of tree. 21 . viii . '14: Corneal wound, lens opaque, curette evacuation and lavage. 26 . viii . '14: Lens remains in pupil, red reflex present. 13 . i . '20: Thin capsule needled.

Final note: 4 . ii . '20, æt. $12\frac{4}{12}$ years. L.V. $\frac{6}{6}$; R.V. s. + 10 = $\frac{6}{12}$ part. R. converges about 20°; on fixation has definite malprojection to the right.

Case 10.—Frank D— (R.L.O.H., Mr. Collins). At age of $7\frac{7}{12}$ years, on 16 . x . '16, L. injured by a fork. 11 . i . '17: L. needling. 17 . iv . '20: L. needling.

Final note: 21 . iv. '20, æt. $11\frac{1}{12}$ years. R.V. $\frac{6}{6}$; L.V. s. + 12 = $\frac{6}{12}$ (3 L). L. diverges slightly, good gap in capsule, fundus normal.

Case 11.—Florence C— (R.L.O.H., Mr. Parsons). At age of $7\frac{9}{12}$ years, on 27 . i . '16, R. injured. 5 . ii . '16: Evacuation of soft lens matter.

Final note: 10 . iii . '20, æt. $11\frac{1}{12}$ years. R.V. s. + 8 = $\frac{6}{12}$. R. divergent about 25°, fair gap in capsule.

Case 12.—Arthur D— (R.L.O.H., Mr. Hudson). At age of $7\frac{11}{12}$ years, on 10 . viii . '16, L. injured by a twig. 15 . viii . '16: Scleral wound, lens opaque, vitreous presenting; conjunctival flap sutured over wound. 8 . iii . '17: L.V. s. + 11 = $\frac{6}{12}$. 30 . vii . '17: L. needling.

Final note: 21 . iv . '20, æt. $11\frac{7}{12}$ years. R.V. $\frac{6}{6}$; L.V. s. + 10 = $\frac{6}{9}$ (3 L.). L. divergent, good gap in capsule, fundus normal, malprojection to the right.

Case 13.—Gordon D— (R.L.O.H., Mr. Fisher). At age of $8\frac{6}{12}$ years, on 19 . ix . '16, L. injured by a pin. 22 . ix . 16: Punctured wound of cornea; lens opaque. 26 . ix . '16: L. needled. 3 . x . '16: L. curette evacuation. 17 . xi . '16: Fundus well seen. 15 . v. '20: L. capsule needled

Final note: 9 . vi . '20, æt. $12\frac{3}{12}$ years. R.V. $\frac{6}{6}$; L.V. s. + 12·5 = $\frac{6}{12}$ (3 L.). Central gap in capsule, fundus normal.

Case 14.—Nellie E— (R.L.O.H., Mr. Fisher). At age of $8\frac{5}{12}$ years, on 28 . xii . '11, injured R. 31 . v . '12: R. needling. 17 . iv . '20: R. needling.

Final note: 21 . iv . '20, æt. $17\frac{5}{12}$ years. R.V. s. + 4·5 cyl. + 3 = $\frac{6}{12}$ partly. R. divergent, good gap in capsule, fundus normal, malprojection to the left.

Case 15.—H. F. P— (private, Mr. H. Juler). At age of 10 years, in 1886, R. injured by a stone. He was in a nursing home some weeks and had one operation (? curette evacuation).

Final note: 3 . iii . '21, æt. 44 years. L.V. cyl. + 0·5 = $\frac{6}{5}$; R.V. s. + 11 = $\frac{6}{6}$. R. divergent about 40°, thin capsule with gaps, fundus normal. Malprojection marked.

Case 16.—Doris S— (R.L.O.H., Mr. Lawford). On 28 . v . '16, at age of $11\frac{1}{12}$ years, R. struck by a wire. 9 . vi . '16: R. curette evacuation. 21 . vi . '16: Capsule adherent to corneal scar, lens matter in pupil. 26 . vi . '20: R. capsule throughout pupil, needled.

Final note: 17 . vii . '20, æt. $15\frac{3}{12}$ years. L.V. $\frac{6}{6}$; R.V. s. + 7 cyl. + 2 = $\frac{6}{12}$ (3 L.).

Case 17.—Thomas H— (R.L.O.H., Mr. F. Juler). At age of 13 years, on 31 . x . '15, R. injured in an air-gun accident. He attended hospital first on 28 . viii . '20, and stated that he had had no operation, that following the injury the vision was slightly affected, but was only completely lost for everything save a bright light six months later. 1 . ix . '20: Small corneal scar, opaque lens remains in pupil, magnet negative, needling.

Final note: 23 . x . '20, æt. 18 years. L.V. $\frac{6}{6}$; R.V. s. + 8·5 cyl. + 1 = $\frac{6}{6}$ part. R. clear gap in capsule. The fundus shows a brilliant group of coloured crystals, green, red and white, close around the macula, which are on or in the retina. There are similar bodies sparsely scattered about the periphery of the fundus and throughout the vitreous. Some

PLATE I.

Fig. 1.—Illustrates Mr. Frank Juler's Case of Intra-ocular Crystalline Deposits (p. 138, Case 17).

Fig. 2.—Illustrates Mr. Charles Goulden's and Mr. Maurice H. Whiting's paper on Epithelial Cysts of the Sclera (p. 316).

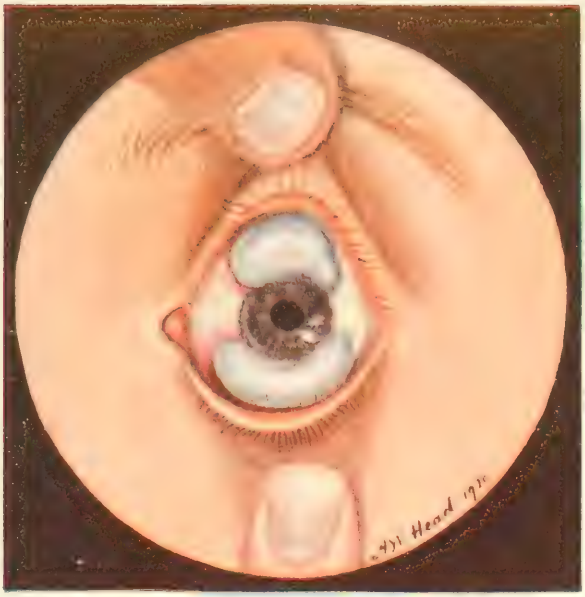


Fig. 2.

Fig. 1.

are also present on the iris and attached to the back of the cornea. By oblique illumination they can be seen floating free in the aqueous, catching the light suddenly as they pass in and out of focus.

This patient was exhibited to the clinical meeting of the Congress, and Mr. Basil Graves examined the eye by his contact-illumination method, which demonstrated the crystals in the aqueous very readily, and also showed a hole in the iris which had been suspected previously. (See Pl. I, fig. 1.)

Case 18.—Gladys S— (R.L.O.H., Mr. Lawford). At age of 14 years, on 18 . v . '18, R. injured (?) by finger-nail. 29 . v . '18: R. corneal wound, lens opaque, curette evacuation. 21 . iv. '20: R. division of anterior synechia of iris. 28 . iv . '20: Needling.

Final note: 8 . v . '20, æt. $16\frac{10}{12}$ years. L.V. = $\frac{6}{6}$ partly; R.V. s + 14·5 = $\frac{6}{12}$ (4 L.). R. small anterior synechia, clear gap, fundus normal, no strabismus.

Doubtful Cases.

Case 19.—Ellen M— (R.L.O.H., Mr. Hudson). At age of $5\frac{1}{12}$ years, on 4 . ii . '13, R. injured by a fork. 27 . ii . '13: Corneal scar, cataract; anterior iris synechia divided, lens needled. 6 . vii . '14: R. needling. 14 . viii . '14: Small gap in capsule. 14 . iv . '20: R. convergence noticed a few months ago, needling.

Final note: 18 . ix . '20, æt. $13\frac{4}{12}$ years. L.V. $\frac{6}{6}$ (H. 1 D.); R.V. = hand-movements. R. slight convergence; small gap in pupil; fundus partly seen, normal down and in; macula and the remainder not seen.

Case 20.—Tom C— (S.M.H.). At the age of $6\frac{1}{12}$ (? $7\frac{1}{12}$) years, in March, 1916, L. eye and cheek injured by glass. Mother states that he recovered and nothing was noticed amiss with the eye until six months later, when the school teacher discovered a defect. Came under observation in 1919. 8 . vi . '19: L. needling. 18 . i . '21: Needling.

Final note: 21 . i . '21: L.V. s. + 13 cyl. + 1 = $\frac{6}{12}$ (2 L.). L. cornea clear, small gap in capsule, fundus normal.

Case 21.—Lavinia H— (S.M.H.). Her age at the time of injury doubtful; she thinks she was about 9, but she has no parents and cannot verify this. She had an operation at Nottingham, but no notes can be traced. 7 . ix . '20: L. needling.

Final note: 10 . ix . '20, æt. 20 years. R.V. s. + 1 cyl. + 3 = $\frac{5}{6}$; L.V. s. + 11 = $\frac{3}{60}$. L. slight convergence, aphakia, gap in capsule, fundus normal.

Case 22.—Ellen T— (R.L.O.H., Mr. Hepburn). L. congenital cataract, R. normal. Born 30 . vii . '12. Mother noticed white in pupil at age of 3 weeks. Brought first 1 . x . '14, when L. was convergent and cataractous, pupil active. 9 . xi . '14: L. needling. 1 . ii . '15: L. needling.

Final note: 31 . iii . '20, æt. $7\frac{7}{12}$. R. normal, L. convergent, no power of fixation. Clear gap in capsule, fundus normal.

Dr. CHARLES F. HARFORD:

In a discussion on the psychology of vision it is a matter of primary importance that there should be some understanding as to the meaning of the terms employed. Unfortunately there are few more abused words than the term "psychology." Any sign or symptom which does not fall within the scope of recognised physiological laws is commonly spoken of as psychological, but without definite reference to any system of psychology.

It is proposed in this contribution to the discussion to sketch in the briefest manner certain views on this branch of scientific thought upon which this paper is based.

(1) In the first place it is believed by the author, in common with many others, that modern discoveries or re-discoveries as to the nature of the psyche are comparable with other great departures in medical science, and are calculated to produce a revolution in medical thought and practice.

(2) It is believed that the materialistic teaching of the medical sciences which has refused to give a place to hypotheses which cannot be demonstrated by anatomical or physiological methods has done much to retard progress.

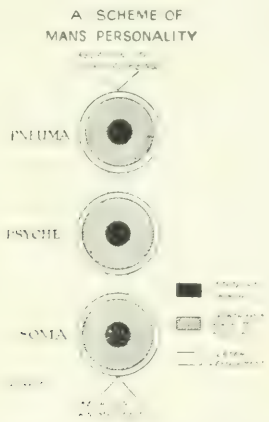
(3) It is contended that the new knowledge cannot be restricted merely to the examination or treatment of so-called neuropathic cases, but is applicable to every department of medicine and surgery.

(4) In particular, it is held that vision affects the psyche, and is influenced by it more than any other of the special senses, and that a proper recognition of this hypothesis may affect vitally the future of ophthalmology.

In order to escape the charge of indefiniteness in putting forward these views, the author has ventured to indicate by a diagram his own ideas on this subject. He believes in what has been designated the tripartite nature of man, consisting of the elements spoken of as pneuma,

psyche, and soma. The shading in the diagram indicates the stages of development which may be presumed to take place in normal cases in three periods of life. The inner nucleus represents the state at birth, the intermediate circle the period between birth and adult life, the outer circle later developments. The reference to pneuma or spirit is only made in order not to neglect this vital factor in the human individual, which profoundly modifies health and vigour. It is also mentioned, as it is believed that the failure of the medical profession to throw light on this subject has resulted in the promulgation of many strange

FIG. 23.



views, which have been disastrous to the well-being of many.

It is, however, to the working of the psyche, the study of which is rightly termed "psychology," that our attention is directed in this discussion. The psyche, which includes all that is expressed by the term "mind," is more comprehensive than the ordinary use of this word. It is the domain of the emotions, the thoughts, the memory and the imagination, and is the recipient of the impressions which come to it from outside through the medium of the special senses and the director of the various activities of which the human body is capable.

Now that psychologists have demonstrated many of the laws which govern the working of the psyche, a new factor has been introduced which must modify our knowledge of the human body, whether in its healthy or diseased conditions, and opens up a possibility of applying new methods of treatment, which are already proving to be most potent in the war against disease.

The most significant discoveries relate to that part of the psyche which is unconscious; these have been made mainly through the method of psycho-analysis. By this we learn that our lives are governed not so much by that part of the psyche which is under the direct control of the will, but by that mysterious force within us which has been developed throughout our lives by the operation of countless influences of many kinds. Some of these are purely physical, as, for instance, the all-important but insidious action of the endocrine glands; some definitely pathological, as in the case of the various intoxications; but the majority purely psychical, including the formative influences of systematic education and the casual intercourse of daily life.

Many of these influences are visual in their origin, and vision in its various manifestations is affected by them.

Psychologists, and in particular the great medical psychologist McDougall, explain the method of working of the psyche by classifying its activities under three heads, which may be described in their relation to vision.

(1) *Cognition*, by which a visual image is recognised.

(2) *An affection*, or the effect produced on the feelings or emotions as a result of (1).

(3) *A conation* or the action of the will produced by (2).

Two diagrams are given illustrating these terms, and indicating the method of operation of the psyche, first in the ordinary examination of a patient for visual defects, and secondly in a case of a psycho-visual neurosis.

I. Visual Tests (Fig. 24).

In the ordinary routine of testing the refraction of a presbyopic patient the following sequence of events may

Fig. 24.

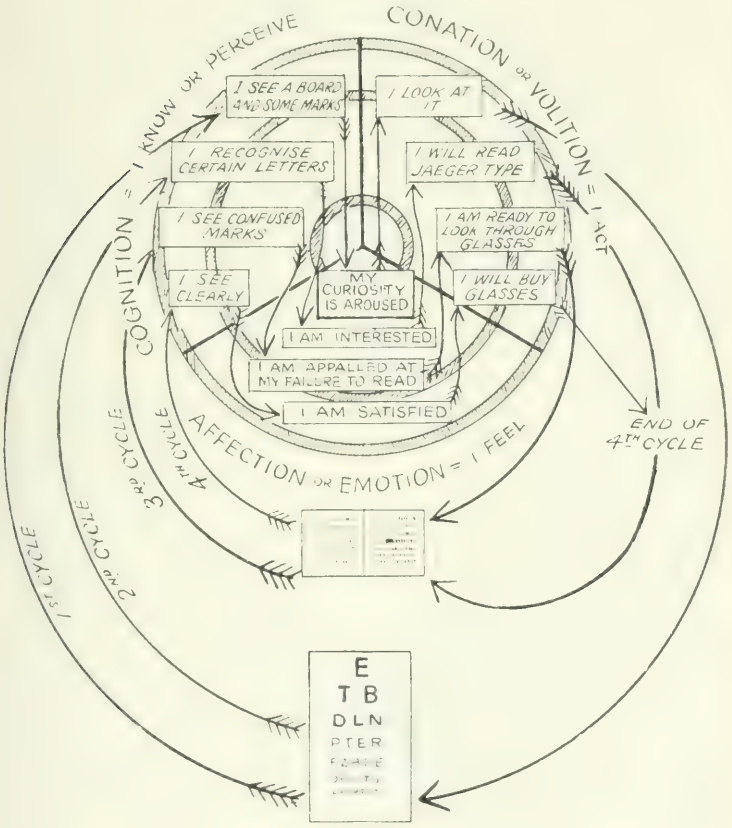


DIAGRAM 2

occur. The patient's attention is directed to Snellen's types, and the results may be recorded under the three kinds of reactions referred to.

(1) He may say, "I see a board."
(2) "My curiosity is aroused."
(3) "I will look at it."

FIG. 25.

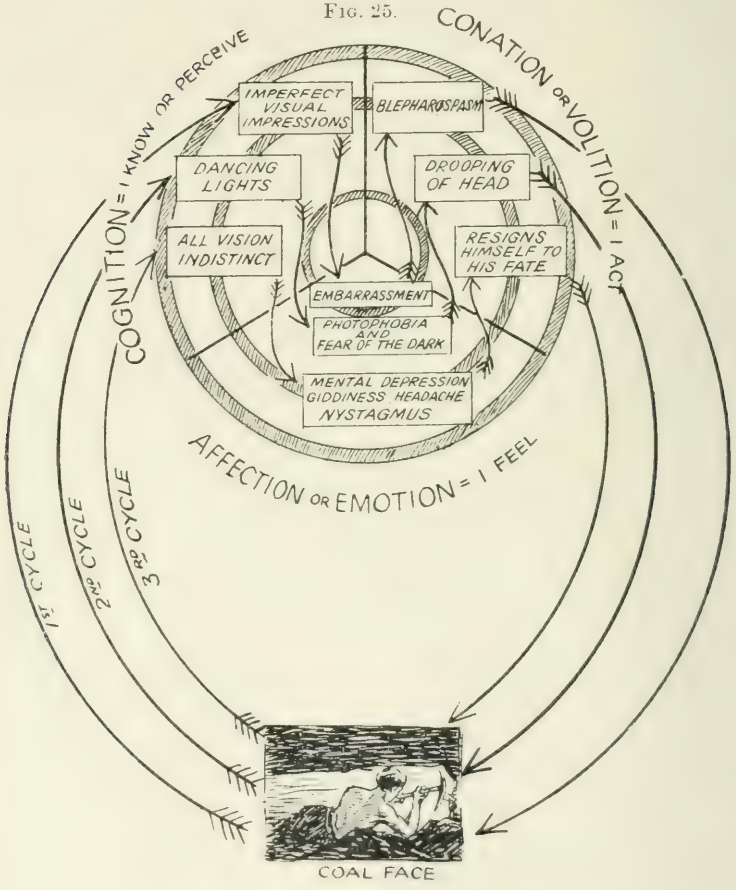


DIAGRAM 3

This completes our first cycle and the second cycle may be recorded as follows:

(1) "I recognise certain letters."
(2) "I am interested."
(3) "I will read the Jaeger types."

A third cycle begins—

(1) "I see confused marks."

(2) "I am appalled at my failure to read."

(3) "I am ready to look through glasses."

The happy result comes in the fourth cycle:

(1) "I see clearly."

(2) "I am satisfied."

(3) "I will buy my glasses."

Unfortunately this is not the story of every case with which we deal. There may be much mind-wandering and side-tracking in the process, with disturbance of temper of both parties concerned. If, however, we realise the mental activities which must be exercised in such an examination, we should aim not only to give a proper prescription for glasses, but to send away our patient with a restful mind, with his fears dispelled, and with a better knowledge of himself.

II. Psycho-Visual Neuroses of Miners (Fig. 25).

Let us now apply the same plan of analysis to the case of what may be called a definite psycho-visual neurosis. The ailment most unfortunately known as miners' nystagmus has been the subject of a previous contribution in the *British Medical Journal* of March 4th, 1916. As a result of army experience it is suggested as a working hypothesis that the following sequence of events takes place, though in this case each cycle may follow the preceding one after months or years. It may be assumed that in this as in other neuroses that are partly visual in origin and partly psychical the psyche is the seat of the inward conflicts, which Freud in particular most graphically describes. These may be accentuated by injuries to the head and other accidents, and the drab surroundings of a mining village. Thus it happens that the subsequent disturbances, visual and otherwise, combine to produce a malady of far-reaching importance.

We start our first cycle with the miners' visual impres-

sions after working on the coal face with insufficient light and perhaps with refractive errors, and we get the following results:

(1) Imperfect visual images, resulting in—

(2) Embarrassment, and producing—

(3) Blepharospasm with irritation of lids accompanying it.

Here the view may be expressed that the dancing lights complained of by victims of this disorder are due to blepharospasm. Anyone can confirm this by observing a row of street lamps and blinking the eyes rapidly. Thus we begin our second cycle with the perception of—

(1) Dancing lights, leading to—

(2) Photophobia on the one hand, and fear of the dark on the other, and as a result of this—

(3) Drooping of the head in a characteristic way, with the cap drawn over the eyes in order to avoid looking at anything.

This leads to the third cycle, in which in severe cases—

(1) All vision is indistinct and the man is practically blind and must be led about, this producing—

(2) Mental depression, giddiness, headache and nystagmus. As a consequence he—

(3) Gives up work and becomes an invalid. If the patient gives up his employment and occupies himself in other ways the symptoms may not reappear, or they may become simply repressed.

Thus in cases met with in the army, of those who had joined up as fit men a fall from a horse or an experience of night operations brought on all the old symptoms, in some cases in their most aggravated forms. Here seems to be a clear case for the exercise of psycho-therapy, and it is hoped that some of those who are skilled in this branch of medicine may turn their attention to this subject.

Other psycho-visual neuroses such as those resulting from astigmatism or diplopia may also produce phobias of various forms more or less definite in character, and

the distress which results from them is a reality which demands our most careful attention and a study of the best methods of obtaining relief for our patients. Some acquaintance with psychology affords the best hope of dealing with these problems, and these few suggestions are made in the hope of stimulating interest in this line of inquiry.

Mr. Claud Worth

remarked that the question of false macula was raised, and he had investigated many thousands of cases of squint, but had never come across an undoubted case of false macula—of true fusion in an abnormal part of the retina. There was also the question of suppression in some of the lower animals who had not binocular vision but in whom the fields sometimes overlapped. He thought there was one thing in squint which threw some light on the suppression of overlapping parts. In a case of squint with no binocular vision and no trace of fusion sense, with good vision in the deviating eye, there was no suppression for moving objects in the part of the field of the deviating eye which was not overlapped by the fixing eye; here moving objects were perceived. That was a common experience if there was good vision.

With regard to amblyopia *ex* anopsia. There was an experiment which was not infrequently, accidentally, made in hospital work. One kept the fixing eye strapped up when the other had lost power of central fixation. If the squint had not lasted during too large a proportion of the patient's life, the sight of the deviating eye would be restored. He had had many cases in which, owing to irregular attendance, the treatment had been kept up too long, and then, after the vision of the deviating eye had become perfect, the originally fixing eye had become, in some cases, very blind, so as to have lost fixation. In one case the child went to India, and the treatment was carried out for such a long time that the originally fixing

eye was nearly blind permanently, and he found it impossible to restore it. There was not now sufficient time for him to go into the proofs, but twenty years ago he published statistics of cases of squint in which the probable age of onset was given, also the vision when all possible means had been taken to restore sight. As Mr. Juler had just said, one could not be certain about the onset age in any particular case of squint. He, the speaker, was careful to take only cases in which one could tell the onset age with reasonable certainty, and in which there was a constant unilateral squint. By taking many cases one worked out the error of chance to a great extent.

Mr. Burdon-Cooper,

referring to the stereoscopic diagram of Prof. Spearman, said that most present realised that the marks produced F F. He noticed that the right-hand F was decidedly smaller and nearer the eye than the left-hand one was, and to his own eye there was a distinct perception of depth. Could not the appearance of the two F's in contradistinction to the T which ought to be seen and the perception of depth be accounted for by assuming that there was an extra effort put into one or other internal rectus muscle (in his case the right), as the right image was nearer the eye than the left.

Mr. Gray Clegg

remarked that one did not often find insanity attributed to eye causes, but that was opposed to the statements of American observers, who ascribed various insanities to small heterophorias. He had a patient who was blind with cataract for a number of years, and after the lens was extracted she had to re-learn her stereognostic sense.

IV. DISCUSSION ON THE TREATMENT OF MANIFEST CONCOMITANT STRABISMUS.

Opening Paper.

By Mr. Claud Worth.

I take it that the duty of the opener of a debate is to provide material for discussion rather than to endeavour to impart information. But it is difficult to put one's remarks in the form of questions when one holds very definite opinions as to what the answers should be. So I will describe briefly my own views and practice, in the hope that those who dissent, as well as those who agree, will give us the benefit of their experience.

The matters to be considered in the treatment of convergent squint are :

(1) Prevention or cure of amblyopia *ex* anopsia.
(2) Correction of refractive error.
(3) Fusion training.
(4) Operation.

(1) *Amblyopia.*—If a constant unilateral squint has lasted for a considerable proportion of the child's life, in the absence of efficient treatment the deviating eye will be found to be more or less blind. As recently as twenty years ago it was an open question whether amblyopia was a cause or a result of squint. Now probably no one doubts that the amblyopia is almost invariably acquired from disuse. The loss of sight is more rapid the younger the child. One who begins to squint constantly at the age of one year may lose central fixation in three or four months. I have never seen central fixation lost in an

eye which began to squint after six years of age. In slight degrees of amblyopia the deviating eye can fix when the other eye is shaded. When vision falls below $\frac{6}{36}$ or $\frac{6}{60}$ fixation is lost. In extreme degrees the sight may be reduced to perception of light.

The only way to prevent or to overcome amblyopia is to force the child to use the deviating eye. This is far more important than all the rest of the treatment of squint.

In a recent squint, to prevent amblyopia or to cure low degrees, the fixing eye should be kept under atropine until it becomes the deviating eye. Then see the child again when the effect of the atropine has passed off. After this the deviation must be kept alternating, one or other eye being atropised occasionally if necessary.

If central fixation in the deviating eye is absent or unsteady the atropine treatment is not sufficient. Then the fixing eye should be continuously occluded. Intermittent bandaging is of little use. The best plan is to seal up the eye with a gauze pad and strapping plaster. The eye may be occluded for days or weeks or even months, until the squint alternates. The case must not be lost sight of, for, after curing amblyopia in the deviating eye, it is quite possible to produce amblyopia in the originally fixing eye. There is a curious fact which throws some light upon the nature of the amblyopia of squint. No matter how young the child or how long the fixing eye may be occluded, the sight of the occluded eye does not suffer so long as the deviating eye is unable to fix. But if fixation is restored and the sight approaches the normal, the vision of the fixing eye quickly deteriorates if occluded too long.

While the better eye is occluded it does not much matter whether glasses are worn or not, unless the deviating eye is very astigmatic.

If central fixation is not restored in the deviating eye after the fixing eye has been occluded continuously for three weeks the case is probably hopeless. But there are

many exceptions, and it is well to persevere much longer than this.

When central fixation has been restored and the sight of the deviating eye so improved that the child can see a ¾-in. ivory ball on the carpet 20 feet away, the pad should be discontinued and the fixing eye kept under atropine, the patient wearing whatever glasses may be required. He will then use the fixing eye for distance. But, having no power of accommodation in this eye, he will, in near vision, use the unatropised eye, which will thus be exercised for a considerable portion of each day. This should be continued until, when the effect of atropine has passed off, the squint alternates.

(2) *Correction of refractive error.*—There is not much to be said about this, except that no child is too young to wear glasses if they are required.

(3) *Fusion training.*—Though there are many methods of fusion training, there are certain principles which must apply to all. The child must be young, generally under six years of age. I have seldom been able to get any useful result from training commenced after this age. The sight of the deviating eye must be good. One needs some optical device by means of which pictures may be thrown simultaneously upon the macular region of each eye. The first and most difficult step in the treatment is to overcome the suppression. Javal endeavoured to accomplish this by continuous occlusion of each eye alternately during several months. This is certainly efficient in many cases, as is shown by the fact that fusion training often proves especially easy immediately after prolonged continuous occlusion of the better eye for the treatment of amblyopia. Another and quicker method of overcoming the suppression is by unequal illumination of the object slides in whatever instrument one is using. Lastly, but by no means least, one must be able to keep the interest and attention of the patient during each lesson.

As regards the practical utility of fusion training, I

take it that at the present time most surgeons are agreed that the essential cause of squint is a defect of the fusion sense. Some hold that it ought to be possible to remove the cause by training the fusion sense; others consider fusion training mere waste of time. In theory the former view is absolutely correct; in practice the truth lies somewhere between these two extremes. Twenty-one years ago I read a paper before this Society upon the orthoptic treatment of squint. Subsequent experience has confirmed everything I said then. But unfortunately the proportion of cases in which fusion training is practicable is much smaller than I thought. In many cases one is not consulted until the child has passed the age limit, and in a certain proportion of cases there appears to be a congenital absence of the potential faculty of fusion, so that, though both images may be perceived towards the periphery of the fields, one or other is obstinately suppressed when they are brought near the maculæ. And the number of visits which may be required is sometimes a difficulty. But in suitable cases and at the right age this treatment yields results which could not have been obtained by any other means. Fusion training is especially work for a young man who has plenty of time, infinite patience, and who is perhaps more in sympathy with young children than he may be in later years.

It must be borne in mind that the object of fusion training is not to correct the deviation, except in small degrees, but to enable the patient to see binocularly when the visual axes shall have been restored to approximately their normal relative directions.

(4) *Operation.*—If measurements from time to time of the angle of the deviation show that it is not decreasing, operation becomes necessary. If there is no hope of binocular vision I usually do not operate until seven or eight years of age. In a case in which fusion training has produced a tendency to fusion with the instrument adjusted to the angle of the deviation, but the deviation

is not decreasing, one may operate at any time—the earlier the better. The "desire" for fusion will suffice to overcome a very small horizontal deviation, but any inaccuracy in a vertical direction will produce persistent and annoying diplopia, which usually can only be cured by further operation. A second image, which towards the periphery may only be perceptible with the help of a coloured glass, may be very obtrusive when it falls near the macula.

A person who does not squint, but who has a moderate degree of hypermetropia and no astigmatism, may perhaps wear reading glasses, but usually will not find it necessary to wear glasses constantly. In the not uncommon case of a patient with a similar refractive error, who has straight eyes and some slight degree of fusion while glasses are worn but whose eyes are strongly convergent without glasses, accurate advancements of both external recti will enable glasses to be dispensed with except for reading. I believe that in such a case any tampering with the interni would be especially dangerous. In the case of a girl whose appearance is of importance, or of a boy whose career might be adversely affected by the necessity of wearing glasses constantly, operation is certainly to be recommended, provided that the surgeon is certain of his ability to perform it accurately.

Formerly I frequently performed tenotomy of the internal rectus in combination with advancement of the externus in high degrees of convergent squint. This practice was finally abandoned in 1905. Many of these operations were followed by divergence long afterwards. And in any case tenotomy makes any approach to accuracy impossible. For many years I have relied exclusively upon advancement alone. Except in very small deviations both externi are advanced. Correction of a large deviation by advancement of one externus only usually causes the patient to keep his head turned away from the side of the operated eye, and it may cause a noticeable retraction of the globe.

In the operation of advancement small variations in technique are not of great importance, provided that certain essentials are complied with.

(1) Sutures in the muscle must have a firm hold which will not give in the least, but they must be so placed as not to cut off the blood supply from the forward end of the muscle.

(2) The sutures must have a secure hold in the sclerotic.

(3) The sutures must pass horizontally from the muscle to the globe. Sutures extending fanwise above and below are apt to give rise to vertical deviations or torsion.

(4) The cut end of the muscle must be held in contact with bare sclerotic during the healing. Intervening episcleral tissue would prevent firm union.

(5) It is of great importance to avoid as far as possible disturbance of the relations of the muscle. If the muscle is dissected out its function is very greatly impaired, and no one can foretell to what extent the mutilation will impair it.

(6) The eye must be kept very still afterwards until firm union has taken place. I keep the patient in bed with both eyes bandaged for ten days after each operation. If one were satisfied with merely approximate results there would be no need to keep him in bed at all, for the sutures would not tear out, but would give just enough to make accuracy impossible.

(7) The opponent must not be tenotomised, for, apart from the danger of divergence, such a proceeding renders accuracy impossible. Moreover it is unnecessary, for with suitable technique and skill in operating one can produce any desired degree of rotation by advancement alone.

Advancement differs from almost every other operation in that no definite measurements or directions can be given or followed. A surgeon who has mastered the technique of advancement and has performed the operation a few times is like one who has bought a violin and

has studied music. Long practice and a certain aptitude are required to make a good violinist or an accurate operator upon the external ocular muscles. After long practice one learns to estimate and to produce the effect required in each case by a judgment, partly subconscious, somewhat similar to that which guides the fingers of a violinist.

There are practically no unavoidable failures in squint operations. The result is a measure of the skill and experience of the surgeon in this operation, and he should be prepared to accept full responsibility for it.

Opening Paper.

By Mr. A. J. Ballantyne.

Mr. President and Gentlemen,—At the outset let me make it clear that in accepting the invitation of our Secretary to take part in this discussion, I do not propose to make any novel or original contribution to the subject. I am here merely as one of the rank and file, more than a little embarrassed in the presence of those who have made this subject their own, whom we gladly acknowledge as our teachers, and to whom we look for still more light on a fascinating but somewhat obscure subject.

Methods of Treatment.

I take it that the methods of treatment of manifest concomitant strabismus which we have at our command may all be embraced under the heads of optical correction, visual training, training of binocular vision, and operation, that all of these are of acknowledged value, and that we are likely to differ from each other mainly in the relative prominence given to each in our practice.

The following remarks are based on my own experience and practice, and refer almost entirely to concomitant convergent squint.

Optical correction.—I suppose there is universal agreement that the first procedure in every case should be an estimation of the refraction and the prescription of suitable glasses for constant wear. In the great majority of the cases there is an error of refraction—hypermetropic astigmatism, or hypermetropia of at least 1·5 D., and the prescription of glasses would therefore be justified on other grounds than the presence of the squint alone. If there is an undoubted squint one need not hesitate to order glasses, even for an infant. If retinoscopy revealed merely a low degree of hypermetropic astigmatism one would not expect glasses to influence the squint, and one would probably postpone the ordering of glasses until the child was perhaps two years of age, but so far I have not met with a case of strabismus in a young infant in which there was not quite a considerable degree of hypermetropia.

Happily in many cases the wearing of glasses is sufficient in itself, or with visual training if necessary, to render a manifest squint latent, and ultimately, in the course, it may be, of years, to abolish the squint entirely. In the remaining cases glasses often help towards the cosmetic effect, and they are an indispensable preliminary to both visual training and the training of binocular vision.

Among those of my cases in which glasses and visual training alone corrected the deviation, the oldest was twenty years of age at the commencement of treatment. Almost all the others were seven years of age or younger. The largest squint thus corrected was one of 40 degrees, the patient being eighteen months old and the squint of two weeks' duration. In the great majority the angle was 15 degrees or less. The spherical error ranged from 1 to 6 dioptres of hypermetropia. In quite a number of them one eye was already amblyopic, and the cosmetic cure was obtained in spite of the persistence of the whole or part of the amblyopia.

Visual training.—With regard to this also, there is

general agreement; if one eye is amblyopic we should attempt to train it.

Opinion is still undecided as to the relative frequency of congenital amblyopia and of amblyopia *ex* anopsia. Everyone is familiar with the part which acquired amblyopia—from corneal disease for example—plays in the occurrence of squint in children of school age, and one is therefore tempted to assume that congenital amblyopia must be a contributing cause in many cases of strabismus in younger children; but in my own experience the shorter the interval between the onset of the squint and the date of the first examination the less one sees of amblyopia, and I am therefore inclined to agree with those who hold the opinion that in most cases the amblyopia is the result of the squint. There is all the more encouragement therefore to make an attempt to restore vision in the squinting eye, although in the majority of the cases the result is disappointing, probably because we see the children at too late an age.

I employ the usual methods of more or less continuous use of atropine to the sound eye combined with occlusion of the sound eye for a stipulated period—say two hours daily.

Operation.—Coming now to the question of operation, I find that I incline to operate now at an earlier age than we were taught to consider safe, and earlier than some of my colleagues; indeed, I do not think that we should lay down any minimum age-limit for operation so long as we do not make any extravagant promises as to immediate results, and do not allow our eagerness for a good immediate result to tempt us to do too much, above all so long as we avoid tenotomies. It is true that in some young children even a double advancement gives a disappointing result, and for no obvious reason; but, in my experience, we can in the great majority of cases get an approximately straight position of the eyes by means of advancements alone, and even a partial correction of the deviation must hasten the ultimate cure and be an aid to

any other treatment that may be adopted. Moreover, I have never seen a permanent over-correction caused by advancement or muscle-folding, and for that reason I would not hesitate to operate at any age, having first, of course, ascertained from six months' trial of non-operative treatment that a cure by these methods was unlikely to be obtained. So far the earliest age at which I have operated is two and a-half years, but four years is not an uncommon age among private cases.

My favourite operations are advancement of the external rectus as described by Worth, and a muscle-folding operation published by Worton in the *Ophthalmoscope*, June, 1914; but I have very little prejudice in favour of particular operations, having seen equally good results from many different operations in the hands of different surgeons. In my hands Worth's advancement can usually be depended on to correct 20 or 25 degrees of convergence, while the muscle-folding operation gives about half of this effect. In young children the latter operation gives one an added sense of security in that, even if sickness, restlessness or interference with the dressings should cause the stitches to yield, the condition cannot be left worse than it was before operation.

In the youngest children, then, I prefer the muscle-folding operation, and if the deviation is round about 25 degrees I operate on both external recti at the same sitting. In children who are old enough to control themselves I employ a single advancement, repeating this on the second eye at a later date if one advancement does not produce a sufficiently large effect.

Tenotomy of the internal rectus I employ comparatively rarely, and never as the sole means of correcting a squint, although I think it may be justifiable in an adult to correct a constant deviation of, say 15 to 20 degrees.

I consider it a mistake to combine tenotomy with advancement at one operation in a patient under sixteen years of age, and even above that age unless the angle of the squint is constant, as there is a real danger of over-

correction. In children it is wise to do too little rather than too much, and if tenotomy is performed at all it should only be as a last resort, and to complete the cosmetic result in cases where double advancement has failed to put the eyes straight. Tenotomy of the internus performed after the permanent effect of advancement of the externus has declared itself, does not produce the extensive and uncontrollable result which follows tenotomy in combination with advancement.

The behaviour of the eyes in the variable squints of young children suggests the existence of a state of excitability and instability of the accommodation and convergence centres analogous to that which causes the uncontrolled movements of limbs and features in other children of a similar age. The operative treatment of the strabismus in such cases may be very disappointing, and although I believe that advancement is often called for, I would avoid holding out hopes of an immediate complete correction of the deformity. I would suggest that in some at least of these cases in which operation fails to produce the effect we desire, the fault does not lie in a slipping of our stitches, but in the fact that we are looking to a mechanical method to correct what is, after all, a functional error, our aim being defeated by a persistent state of hyperexcitability of the convergence centre. The prospects of a cosmetic cure from operation are better the older the patient, and in my opinion it is only in the case of a long-established and constant squint in the adolescent or adult that one can talk of estimating accurately the angular effect of any particular operation. This, I suppose, commits one to the view that as time goes on the strabismus becomes more of an anatomical deformity and less of a functional deviation—a view which is supported by the general inefficacy of optical and orthoptic treatment in older patients, and by the fact that in many cases the convergence persists, even under the combined influence of atropine and chloroform.

Training of binocular vision.—I have dealt first with

the optical and operative treatment, because there is likely to be general agreement as to their application, and now I come to the training of binocular vision, or, as Mr. Worth terms it, the training of the fusion faculty, as to which, I imagine, there will be a good deal more room for controversy.

I had not been long in ophthalmic practice when Mr. Worth published his important work on squint, and, like many others, I took up the matter with considerable interest. I was naturally able to devote some time to my cases, and I tried to carry out the method of amblyoscopic training conscientiously. I have to confess that my results were disappointing. In most of my cases I scarcely succeeded in getting the child interested in the "game," and for some years my amblyoscope has been used almost entirely for purposes of examination and diagnosis. Although I have had one or two successes, I cannot say that my "cures" were entirely or mainly due to my fusion training. These few cases would perhaps have made as good a recovery without the exercises. In this connection I should like to refer to an observation made some years ago by Dr. H. Wright Thomson, of Glasgow. He made inquiry among the boys and girls of about fourteen years of age in one of the large public schools, to ascertain how many of them had suffered in their earlier years from squint, and had "grown out of" the defect. I cannot give his figures, but he tells me that he was surprised to find how many there were who had not only recovered spontaneously from the strabismus, but who manifested the highest grade of binocular vision. Perhaps some of the subsequent speakers may have made observations on this point, which seems to suggest that a delayed development of the fusion faculty may occur, and may contribute to the spontaneous cure of strabismus.

To return to the amblyoscope: my own experience having been so disappointing, I have made inquiries among my colleagues in Glasgow, and find that that experience has been the general one. Only one of my

friends claims to get valuable results from the practice of fusion-training. He prescribes exercises with the amblyoscope to be carried out at home, combined, of course, with systematic visual training where that is necessary. It will be interesting to learn from this discussion how far orthoptic training has succeeded in establishing itself in the practice of members.

Now, although I confess to something like failure with stereoscopic training, this does not imply any disbelief in the results obtained by others, or want of faith in the scientific basis of the method. Admittedly the work is difficult and needs much time and patience. In my own case I find a lack of ability to interest the younger children in the pictures and to make them understand what one wants; but, believing as I do that the rational treatment of strabismus, like the treatment of other disorders, should be based on accurate knowledge of its pathogenesis and of the physiology of the organs concerned, and believing that the orthoptic treatment of squint has such a basis, one has a guilty feeling of a duty neglected when the amblyoscope is allowed to lie on one side unused. Even if the number of cures wrought by orthoptic training is small, I think it cannot be denied that the conception of a defect of the fusion faculty as the underlying and unifying factor in concomitant strabismus is the greatest advance in the theory of squint since the work of Donders, and that it opens up the way to an immense advance in treatment. In one sense the recognition of the trainability of the fusion-faculty is a much bigger thing than Donders' conception of the relation of strabismus to ametropia, for it seems to satisfy our search for the primary factor which underlies all concomitant squints, and, after all, Donders placed the emphasis on one of the accessory factors. His work has been justified by the results of purely optical treatment, but the cure of squint by the use of glasses falls short of our ideal in that it is consistent with the persistence of a unilateral amblyopia, and is often only a cosmetic result

without the establishment of binocular vision. The same, of course, is true of operative treatment. If we conceive of strabismus, not as an anatomical deformity but as a functional disorder, in which the most important element is the lack of binocular vision, then the last word in treatment lies with the stereoscope.

Investigation of Cases of Strabismus.

Although I have admitted that the difficulties in the way of the employment of stereoscopic training have, in my case, prevented its adoption as a regular method of treatment, I have become more impressed with the desirability of investigation of the fusion faculty, along with the motor functions of the eyes, as a preliminary to the operative and other forms of treatment. In deciding, for instance, to aim at obtaining a smaller or greater effect by operation, the angle of the squint alone is not a reliable guide. A preliminary investigation with the amblyoscope will show that in a certain proportion of cases there is a total absence of the fusion faculty, or even an apparent "antipathy to binocular vision." I believe that in such cases the results of operative treatment cannot be accurately foretold, that it is better to do too little rather than too much, and that tenotomy of the internal rectus muscle is to be avoided, unless we are dealing with a fully-grown adult. The uncertainty of the operative effect in such circumstances was illustrated by two recent cases. One, a lad, æt. 21 years, had a convergent squint of about 35 degrees; he was almost emmetropic and had good central vision in both eyes. Two satisfactory advancements left about 10 degrees of convergence. The other, a boy, æt. 12 years, had a convergent squint of 45 degrees, with over 6 dioptres of hypermetropia, and one eye was amblyopic. A single advancement, performed in the usual way and expected to give about 25 degrees of correction, produced a marked divergence, which, even with the abandonment of

glasses and atropine, lasted two months and then gradually passed into a slight convergence.

When one considers the large variety of factors which enter into the pathogenesis of concomitant strabismus—shock or illness, accommodation excess, anisometropia, temporary reduction of visual acuity or occlusion of one eye, congenital amblyopia, heterophoria, temporary paresis of an external rectus muscle, defective development of the fusion faculty, and so forth, it seems certain that the same treatment will not be suitable for every case, and that it would be wise, before commencing treatment, to investigate not only the refraction, the visual acuity, the angle of the squint and the field of fixation, but also, so far as the age of the patient will permit, the field of vision, the amplitude of accommodation and convergence, the presence or absence of vertical deviation and the state of the fusion faculty, always bearing in mind that the ideal treatment of strabismus must be based on an accurate knowledge of the pathogenesis of the disorder and of the physiology of the functions concerned.

It is here that the limits seem to be set to further advance in our methods of treatment. There are a number of unanswered questions with which we are all familiar; for example, why is it that some persons with undeveloped binocular vision, amblyopia and hypermetropia have straight eyes, while others with good visual acuity, a good optical correction, and at least a certain desire for binocular vision, continue to squint? If the cause of the average convergent squint is a combination of hypermetropia with a defective development of the fusion faculty, and if, as we are told, a child begins to accommodate and converge as early as the third month, why is it that squint is relatively so uncommon, and why is its onset so often delayed until the third or fourth year?

Again, how is it that in some cases amblyopia *ex* anopsia develops in the course of a few months, while in other cases a monolateral squint may persist for years

without deterioration of vision? Or why is it that one child "grows out of" a squint, while in another an occasional strabismus develops into a constant one?

Perhaps an answer may be found to such questions some day; meanwhile they are rather outside the scope of our present discussion. My point is that there are considerable gaps in our knowledge of the pathogenesis of strabismus, and even of the physiology of binocular vision, which will need to be filled before the scientific foundations of our treatment are complete.

We are apparently born with a certain racially-acquired degree of binocular equilibrium; but the finer co-ordination of the eyes which is necessary for binocular vision has to be learned, like the act of walking, by each individual, and I would suggest that the most useful, if at the same time the most difficult, line of inquiry lies in a closer study of the evolution of binocular vision in the growing child.

Mr. E. E. Maddox:

The problem of squint is that of John Gilpin, namely, a runaway horse with a weak rider. The converging centre is the runaway horse, the reins of which are lost by the rider, namely the fusion reflex.

For the non-operative cure of squint we need to do two things: firstly, to find out why the horse runs away and pacify it, and secondly to strengthen and train the weak rider to pick up the reins again and bring it under control. Mr. Worth has shown us how best to do the latter, and the amblyoscope is, I think, the best instrument for the purpose. Lest it should fall when placed in the hands of a child, I keep it slung from the ceiling on a pulley with a counterpoise, with two strings which proceed to the prospective tubes of the instrument, and as they tend to close the apparatus up a little when the child's hands become tired, I separate them by a cross stick of such length as to keep the instrument open at

the angle for normal vision, unless pressed in by the child. In this way every yielding of the child's hands tends to train the squint in the right direction.

It must be confessed, however, that though I often make efforts at training, successes are few, and I quite agree with Mr. Worth that after six years of age the difficulties become almost insuperable. In a few cases I have succeeded at much greater ages, but I mainly use the amblyoscope for diagnostic purposes.

So much for the rider; now for the horse. Donders made a great advance towards its pacification by the correction of hypermetropia, so as to cut off from the converging centre the perpetual incitement to over-activity from the linked reflex of accommodation. It occurred to me some time ago that we might also take advantage of the well-known physiological fact that *convergence tends to lessen on looking upwards.* I therefore sometimes frost the lower face of the correcting lenses, or better still prescribe bifocals, which keep the children looking more or less upwards to see distant things normally. This frosting or excess of correction can be extended over the whole of one lens, if the case requires semi-occlusion of the best eye at the same time.

Another fact sometimes lost sight of is that *the converging reflex has its own proper stimulus,* namely the sensation of "proximity" of objects seen or thought about. For this reason squinting children should be forbidden fine or close work as much as possible, and their toys and educational implements be large and distant.

These are only small points accessory to operation, occlusion, and fusion training. The latter is often disappointing even when successful. I have at present two boys, æt. 14 years, whom I have taught to succeed in uniting nearly all the usual stereoscopic diagrams, but in whom the fusion faculty thus restored does not suffice to conquer even the low degree of squint which they retain, though it would no doubt have done so if undertaken at a very much earlier age.

To put one's experience in a nutshell, the easy cases are very easy, and almost cure themselves if operation be performed early enough, but the difficult cases are very difficult, and almost unconquerable, needing exceptional ardour in both patient and friends, and even then the results are often poor. Fusion training is useful for cases which are nearly curable without it.

Mr. T. Harrison Butler

said that fifteen years ago Mr. Worth's book came into his hands; he found it very fascinating, and his practice had been founded upon it. But, with the passage of years, he had "fallen from grace," so that there must now be very little of Worth's methods in his practice.

With regard to amblyopia *ex* anopsia, Mr. Worth said that at the present day there were very few ophthalmologists who threw doubt on the theory. He thought Mr. Worth could not have read a recent French paper pointing out that the whole idea was not only illogical, but was founded on no single fact. He, the speaker, thought there was much in amblyopia *ex* anopsia, but many surgeons did not believe in it at all. There was need to come to the practical details of the work, and that was why the Council chose this subject for discussion; fusion-training had been practised for fifteen years, so there must be some knowledge of it. He did not think he had ever thoroughly understood it, though he had done his best and had read Mr. Worth's book and tried the methods. He could recall only one case in which he had had success with fusion-training, that of a boy, but in a year he had relapsed somewhat. From the information he gained from public speeches and conversations with colleagues he wondered who was carrying out fusion training. A little time ago a little girl with squint came to him, and he fitted her with glasses. He talked to her mother about fusion-training, telling her he had not had much experience or success with it. But as she was

going to Bournemouth he told her to see Mr. Maddox, who was a leading authority on fusion-training, and he would carry out a course. But Mr. Maddox did not do so, and the child came back again.

With regard to treatment of amblyopia *ex* anopsia, there again, during the past fifteen years, he had been occluding eyes, and the children had worn pads for months, yet the number of cases in which he had seen improvement of vision was very small.

There was one practical point which a patient taught him. Mr. Worth had stated it was somewhat difficult to get a patient to wear glasses with the pad, but one of his (the speaker's) patients pointed out to him that if the pads were sewn to the spectacles it was easy, and he had found it so. Fusion-training must be done under five years of age, but children were very difficult to educate in such a scientific procedure as looking through an amblyoscope, or any other form of instrument, and in regard to a stereoscope, many grown-up people found it difficult to understand what was meant by getting a solid effect.

A good deal was said about binocular vision, but who wanted binocular vision? Had any member of the Society had a patient come to him and say, "I have not binocular vision"? And the people now being discussed did not say they were handicapped by not having binocular vision. A person who lost an eye was handicapped for a time, but afterwards he got over the disability. The idea of doing an operation for squint was to make the patient beautiful.

Operation was a most important part of this subject. First as to the age for operation. He regarded it as a cosmetic operation, and he chose the age which seemed to him to be most suitable for that. He fixed upon eight years. He did not think he had done an operation for squint under an anæsthetic for many months. When he was dealing with a child he first talked to him, asking him how many brothers and sisters he had, and

generally put him at his ease. He then injected a few drops of codrenine over each muscle, talking the while. In some cases the child began to cry, but that did not necessarily mean there would be trouble with him. Last week he had a case in a rather fretful child, but it was quite good during the whole operation. If it seemed to him that a child could not be operated upon without an anæsthetic, he sent it home to wait for another year.

The next question was, For what degree of squint did one operate? Those who had seen cases of squint for ten years knew that nine out of every ten tended to get better. How many hypermetropes with 8 to 10 D. had a squint? Most had no squint at all, even when one eye was amblyopic. He did not think the slight degrees of squint needed to be operated upon; he would put the minimum for operation at 25 degrees; the enormous squints of 35 to 45 degrees one had to operate upon. For large squints the combined operation came more into practice. After what he had heard to-day, however, he did not think he would do fewer tenotomies in future. In the past he had not had the successes he would like, therefore he had tenotomised the central tendon, and included that in his suture. He took it that the tendon had grown in the place it was removed from, or had been slightly advanced, and he had done it only to prevent the stitches being pulled out. One put the stitches into the sclera or the episcleral tissue, and two or three days afterwards the eye was in a good position; but on the fourth day the stitches had moved back 2 or 3 mm. He had not seen failure from stitches cutting through the muscles, and he had given up twisting the stitches round, or putting knots in. He put them once through the muscle, and he did not use retractors or forceps. When the operation was done and it looked like a failure the surgeon should not be despondent, because one did not know for six months what the result would be. One girl was going to America and he did

an operation, and, apparently, there was no result. He arranged for her to come and have it done again, but when she came the eye was quite straight. That case had been a lesson to him. Practically all the squint cases were among the children of poorer people. With regard to older patients, one was, in them, putting one's stitches into firmer tissue and they were less liable to tear out. A little time ago he had a child with a definite squint of 20 degrees, and when he tested her she succeeded with Hering's drop test. How could it be said that squinting was due to loss of the fusion faculty when a child with a 20-degree squint could do the Hering test? It was a very stringent test for the highest grade of binocular vision.

Mr. M. S. Mayou:

I wish to confine my remarks practically to the operative treatment of squint. It is a subject one is apt to be dogmatic about, principally because one finds a line of operation and adheres to it; the surgeon gets better results by keeping to one type of operation than otherwise. If a patient has good vision in both eyes and has some attempt at fusion, I think it is well to operate as soon as possible, provided the patient has worn glasses for a year, or possibly longer, without improvement. With the idea of getting the eye straight, or nearly straight, fusion may be obtained early. If the squinting eye is completely amblyopic there is no object in putting the eye straight except for cosmetic reasons, which can be done at any period when the parents or the patient so wishes it.

With regard to operation in convergent strabismus for any angle up to 15 degrees I do a tenotomy of the internal rectus, but in young children 20 degrees can often be corrected by it. If one attempts to get more than this out of a simple tenotomy by dividing the tendon expansion one is very apt to get a divergence. In doing a tenotomy of the external rectus one only produces an

effect equal to about an 8° prism, so that if a manifest divergent squint is present it must always be associated with a tenectomy of the internal rectus. For convergent squints of from 15 to 45 degrees I do an advancement, or more strictly speaking a tenectomy associated with the tenotomy. Personally I think an advancement alone without tenotomy of the opposing muscle is unsound surgically. Firstly, because one leaves an opposing muscle attached to the globe which, when it is put into action, tends to detach the advanced muscle from the globe by pulling out the stitches, whereas a tenotomy, at any rate temporarily, paralyses the muscle and allows the advanced muscle to heal on to the globe firmly. Secondly, an advancement in its true sense of the word—that is to say, a pulling forward of the tendon in front of its original attachment—I do not consider a good operation, because of the great difficulty of getting a proper hold with the stitches in the sclera, and because it leaves an ugly scar far forward near the cornea, which is conspicuous for a very long time afterwards. Therefore, personally I prefer a tenectomy—that is to say, a shortening of the tendon with the use of the stump of the muscle attached to the globe for holding one's sutures. Thirdly, if the angle of the squint is at all high and the muscle is advanced sufficiently to correct it, it will produce a certain amount of enophthalmos.

I think it is most important that both eyes should be tied up after any squint operations, so as to keep the eyes at rest.

Mr. N. Bishop Harman :

That a defect of cerebration, involving a weakness or possible absence of that most human desire for binocular vision, is at the basis of manifest squint is, I take it, a matter of general agreement. The determining factors responsible for the onset of the squint may be many, but they are capable of grouping under three heads : Defects

of the eyes, defects of the muscles, and toxic influences, using the last term in its widest meaning.

In this communication I wish to suggest what is, according to my judgment, the most probable determining cause of the three, and consider what influence such a determining factor, combined with the conditions of the primary origin of the disorder, must have upon the possibility of cure and of the measures we may employ to effect this cure.

Binocular vision is a late acquisition in the development of man, both phylogenetically and ontogenetically. And just as with other late acquisitions, *e. g.* the erect position, it is easily disturbed, especially when it is first coming into exercise. When firmly established it is susceptible to disturbance by toxic influences, but otherwise it can be maintained against odds which are truly astonishing. The strain involved in maintaining binocular vision under abnormal conditions is so great that I am inclined to consider squint as an attempt on the part of the organism to escape the strain. An uncorrected heterophoria of even small degree will make life burdensome to the sufferer, but I have never heard of a manifest squint causing symptoms of strain.

Error of refraction is, I suggest, much less likely to be the determining cause of squint than we are accustomed to allow. If it were, squint would surely be much more common. In an examination of the refraction of 368 infants in a higher-grade school in London, of which I gave the details before this Society,* only 8 children had emmetropic eyes; the others had errors of refraction, mainly hypermetropia, and no less than 126, or 34·9 per cent., of these errors were of considerable and even high degree. Yet amongst all these children there were only 8 squinters, or 2·17 per cent.—a figure which agrees with that found over much larger numbers of school children.

If error of refraction were the leading determining

* *Trans. Ophth. Soc.*, 1919, p. 89.

cause of squint I think we might reasonably expect that squint would be much more common that it is. And on the same assumption we should expect the correction of the error, especially when this is done at the onset of the disorder, to be much more effective. The infrequency of squint and the commonness of error of refraction, and the fact that only a minority of early squinters are relieved by glasses, are facts that argue that refraction must take a secondary place amongst determining causes.

Toxic conditions, similarly, cannot claim a high place, for these are exceedingly common in childhood. It is true that squints are often dated, and by intelligent parents, from some fever such as measles, but although we must allow that the febrile attack had its influence, there is no proof of its being the greatest influence. For why should there not be recovery after the cessation of the fever? Not uncommonly the squint is at first intermittent, and its fixity comes on at a later date when the fever is almost forgotten.

The alternating squints, particularly where there is no error of refraction and febrile attack, injury or shock assignable as a determining cause, are insoluble unless some other probable factor be found.

Defective muscle balance is the remaining possibility as a determining cause. I suggest it is the most probable and most influential of all factors. Its importance does not appear to be sufficiently recognised to-day, and particularly the influence it must have upon our schemes of treatment. If we examine the relation of the muscles to the globe in the fœtal orbit we note that the muscles are all retrobulbar. The huge globe nearly fills the cavity, and it is only when the orbit takes on a more rapid growth than the globe that the muscles come into relation with the sides of the globe. In some fishes there is a regular "defect" in the ocular attachment of certain muscles. In the herrings and some salmon the internal rectus fails to gain an attachment anterior to the equator of the eye: it is attached close to the optic nerve; the

other muscles have the usual attachments. Again, in the Pleuronectids the external rectus is "deficient" in form as judged by the usual standards.* Gross defects of the musculature causing varieties of squint are known in man; they are sometimes hereditary. Much more common are defects of balance, which usually are not discovered until adult years, but may be found in young children. Heterophoria does not necessarily lead to squint, but I have seen this sequel when the vision of one eye has been dimmed by cataract. In one such case the onset of the squint produced a ghostly second image of the object seen by the squinting cataractous eye, to the great discomfiture of the patient. In another the divergent squint existing with the cataract was relieved when the cataract was removed. It is sometimes possible to note how nearly heterophoria has produced a manifest squint. I have two children patients, distant cousins, whose cases illustrate this point well:

Boy, æt. 9 years, noticed to squint after air raids and in cold weather. Aching behind the eyes. Vision $\frac{6}{6}$ each eye, H. 1 D. No manifest squint, but some latent convergence. Seen at intervals during two years; at last examination 4° of esophoria and 1° of right hyperphoria. Balance is maintained with glasses.

Girl, æt. 7 years, said to squint on and off the last three years. Headaches lately. Vision $\frac{6}{6}$ each eye, H. 0·5 D. Good binocular vision, passed tests with ease. It was thought that the squint was a mistaken impression due to a slight degree of epicanthus. Seen five years later on complaint of tired eyes. Vision as before; 2° of right hyperphoria found.

If these two children had been drafted into an elementary school at the age of five years, gone there wet or fine, been occupied with school work, fit or unfit, for five hours a day, and had succumbed to such febrile attacks as a collection of children would expose them to, the odds

* *Journ. Anat. and Physiol.*, vol. xxxiv, pp. 20 and 35.

are that the intermittent squint observed by the parents would have become fixed, and the underlying muscle defect would not have been discovered.

When we consider how extreme are some of the cases of heterophoria where binocular vision is maintained, we cannot be surprised if the most of the cases of this sort are converted into manifest squints if the desire for binocular vision is not of the highest, or if conditions of health are unfavourable to the strain of maintenance of it. Let me cite a case.

Man, æt. 38 years, sent to me by a well-known ophthalmic surgeon with this history: Very bad headache from school days. Wearing prisms R. 8, L. 9, bases out. Esophoria 30°. June, 1916, he divided the right internal rectus thoroughly. August, 16° esophoria; left internal rectus divided thoroughly. He was sent to me with the suggestion that I should reef the external rectus. On examination I found vision each eye $\frac{6}{6}$, 0·5 D. astigmatism with axis against the rule, 18° of esophoria and 1° of hyperphoria. Muscle movements full in all directions. I did a reefing advancement on the right external rectus, tightening up the sutures until the Maddox rod showed an excess of correction of 1°; no hyperphoria remained. A fortnight later the result was excellent; tests with the rod showed orthophoria when the test was first tried and then a variation between the perfect position and 2° of esophoria; no hyperphoria. Seen three years later he stated that he had had perfect comfort since the operation.

We are amazed when we come across extreme cases such as these, and I suggest the fact that they are exceptional is probably due to most of them being lost in the all-obscuring condition of manifest squint.

It has been urged against the determining influence of muscle-defect that lack of muscle-power should be associated with it, and that this should be measurable in squint. I do not think that this is a conclusive argument, for I have not found any general deficiency in power

in cases where heterophoria of the type I have cited existed.

If we admit the leading influence of muscle-defect as the determining cause of squint, our methods of treatment are obviously at fault. What use can there be in a prolonged course of "orthoptic treatment"? The squint is, in effect, an effort to get rid of the strain that the maintenance of binocular vision involves, so that a cure on these lines is hopeless. Again, the very nature of binocular vision, as we who possess it to the full know it, indicates that this method of treatment is almost against Nature. The phenomenon, known as the "struggle of the retinæ," proves that the brain objects to the presentation of dissimilar objects to the two eyes at one and the same time; it prefers to record one or other of the two, and the possessor of good binocular vision sees first one and then the other object, each apparently wiping out the perception of the other in turn. If this be so for us, what can we expect of squinting eyes where the binocular vision faculty is weak or in abeyance.

There is a further observation on the likelihood of effective results from orthoptic methods. It is a matter of common knowledge how difficult it is to recover the vision of a squinting eye. Complete and continued occlusion of the other eye, so as to compel the sole and constant use of the squinting eye, may fail even with a comparatively early squint. If continuous and compulsory exercise of a macula be so uncertain of effect, what effect can we expect to secure upon a complex brain-centre not susceptible to conscious direction by half an hour's practice a day?

If we concede that muscle-defects are likely to be the chief determining cause of squint, this probability, together with the known peculiarity of the fusion faculty, makes it certain that early operative correction of the squint is the only rational method at our disposal. If the constant use of glasses that correct any error of refraction does not effect a rectification within a month, we may conclude

that glasses will not correct the squint. Any time allowed to elapse between this conclusion and operation, except so much as may be employed in attempting to regain the sight of the squinting eye, may be considered as lost time, for it has by so much delayed the prospect of bringing the two maculæ into correspondence once again.

Such a conception of our responsibilities necessitates the development of methods of operation that can be carried out satisfactorily in very young children, when the requirement of general anæsthesia and the smallness of the palpebral fissure makes operation most difficult, and methods that give such a uniform measure of success that doctors and parents will wish for operation early rather than late.

At the Belgrave Hospital there has recently been formed an operative clinic for squint. An attempt is being made to get these cases early. The usual clinical methods are first tried. Glasses are ordered where there is an error of refraction, in the hope that there may be a reduction of the squint. If this fails, or fails at a certain point after the lapse of one month, then the aim is by occluding the fixing eye to improve the vision of the squinting eye where that is diminished, so that this eye would be capable of doing some work if it were straightened. The most favourable response is a reversal of the squint, so that the original fixing eye becomes the squinting eye; next to that is the regaining power to fix with the squinting eye, if only for a few moments, when the other is uncovered. With either of these responses the prospects of operation are at their best. If these responses are wanting on three months' trial the time for such response is passed, and operation is done with the aim of bringing discontinuous efforts into continuous effect, or merely for cosmetic effect.

The method of operation is shortening of one muscle by "subconjunctival reefing," with lengthening of the antagonist by "tenoplasty." By this method one is able

to calculate on paper beforehand just what one intends to do, and to do it under general anæsthesia, with an almost mechanical exactitude and a minimum of anxiety. Since the description of the operation was published with the detailed results of the first hundred operations* further experience has led me to simplify the procedure. I now employ reefing only, and without advancement, in nearly all cases. The blinker and the fixing of the eye after operation with suture and strapping have been discarded. Reefing and tenoplasty entail a minimum of interference with the tissues; scarring is hardly perceptible a month after operation; there is never any lump. This, and the smallness of the limitation of the liberty of the child, allow the adjustment to be effected by the use of both eyes, one after the other, if necessary—a procedure far more likely to be productive of a true balance of the eyes than the forcible turning of one eye. The advancement of the reefing sutures is now only practised on rare occasions in extreme squint of older children where the whole effect is desired by operation on one amblyopic eye.

The new clinic at the Belgrave has been in working one year. Forty cases have been operated on. The great difficulty at present is getting the cases at an early enough age. The ages on first attendance ranged from 4 to 14 years, the numbers for each year from four onwards being 1, 3, 4, 6, 10, 4, 3, 5, 2, 1, 1, so that 80 per cent. were of seven years of age or over. It is not surprising to find that of the fixed squinting eyes, excluding alternating squint, no less than 45 per cent. had no or dubious fixation. Treatment of such cases is little more than beauty doctoring. But it is hoped that the persistent efforts of the school medical services of the country will bring to the minds of teachers and of parents a better appreciation of the loss to the child which an uncorrected squint means, so that the possibilities of scientific treatment may be advanced.

* *XVII International Congress of Medicine* (*London*), *Ophthalmology*, pt. ii. p. 313.

Mr. A. L. Whitehead

said he had not prepared any remarks to contribute to this discussion, but he would like to give his own personal experience, and to comment on what had already been said.

His own experience had been very much like Mr. Harrison Butler's, *i. e.* to find that persistent squint was much more prevalent in hospital than in private practice, and that it was much less frequently necessary to operate on private cases. His custom was to correct the error of refraction fully and accurately; to this he attached a great deal of importance, even though the eye might be amblyopic. He did not know what the *rationale* of that was. As to the length of time during which the treatment should be carried on, he understood Mr. Bishop Harman to say a month was the time he continued it. He believed most ophthalmic surgeons would agree the time should be six months at least, perhaps twelve months. Moreover, a certain number of cases underwent spontaneous cure—a fact to bear in mind. As a rule he adopted the method of bandaging, four hours a day, the better eye, usually two hours in the morning, two in the afternoon. He, like others, was seized with joy when he heard of the amblyoscope, for he thought it meant that at last the cure for squint had been found. He worked hard with this instrument on a number of cases, but, except in two or three, he could not satisfy himself that it even afforded him help; he was sorry to say that so strongly. And as one got older one found less time available for its use; that might have had something to do with its abandonment.

With regard to operation when it became necessary, it had been interesting to-day to hear different men with wide experience telling the Society what they did. He himself had no fixed custom, but he was inclined to agree with Mr. Mayou in his preference for tenectomy with tenotomy. With advancement and tenotomy he had had some bad results, and frequently he had over-corrected, but he had never over-corrected with tenectomy and

tenotomy. Sometimes he did advancement alone. Mr. Ballantyne did not say which operation he performed; perhaps he would let the meeting know in his reply.

What was to be done in the case of young adults who had worn glasses for years, and who had good vision and comfort while wearing their glasses, but on removing them they squinted? When they came in order to have their squint remedied what ought to be done? If an advancement were done so as to get a good cosmetic result, they were not comfortable when they wore their glasses; they had a divergence and headache.

Another class of case which gave him food for thought was that in which there was an alternating squint with good vision in each eye, and often without glasses, or with glasses of very low correction. Those cases caused much difficulty, because the advancement in both eyes was not always successful. On the whole he thought double advancement was what should be carried out in these cases. He had never tried Mr. Bishop Harman's reefing operation, and he would like to hear from other speakers besides Mr. Harman what their results from it had been, because an operation in the hands of the inventor of it would give results which others did not always obtain.

Mr. Brooksbank James

agreed that no form of mirror stereoscope was really of much value in orthoptic training, though it was useful for the purpose of detecting the presence or absence in a given case of the fusion faculty. It was his practice to order glasses at the earliest age, and to insist on alternate occlusion of the eyes until the squint was cured, with or without operation. For occlusion he used a square of black paper, sewn to the outside of the glass; the inner edge of the square reached the centre of the bridge; the lower inner edge was cut away to lie closely against the nose, and the upper and lower edges reached well beyond

the margins of the lens. He had found this perfectly efficient except where the power of fixation in the squinting eye was lost, and an endeavour was made to restore it; in such a case more drastic measures were necessary. To cover one eye for a few hours daily did not prevent the habit of suppression, nor did the use of atropine in the good eye. For orthoptic training he used a small black box, containing a flash-lamp. The box had a ground-glass aperture, and in front of this a piece of black paper with a vertical row of pinhole apertures was placed. The illuminated line of dots thus produced was approached to the patient's eyes, who should be wearing spectacles containing + lenses in addition to his distance-correction, the room, of course, being darkened. When the line of light approaches within the near point of convergence diplopia is produced in a great majority of cases, and the patient's attention is drawn to this, and he is encouraged to note the fusion of the images. It will be found in many cases that by degrees the images can be seen double and fused at an increasing distance from the eye, and ordinary objects, such as a white stick against a black background, can be substituted for the streak of light. The early exercises can be done under atropine. During the intervals between the exercises rigid alternate occlusion of the eye should be practised. With regard to operation, he performed a central tenotomy, continued the exercises and waited for some time. Later, if necessary, he performed an advancement. He was reluctant to operate on very young children, as in a number of cases he had seen the complete restoration of binocular vision at a later age, even in cases where one eye was markedly amblyopic. He would like to make one remark with reference to the cause of convergent squint. It was very probable, in his opinion, that the blind spot played an important *rôle* in facilitating the suppression of the false image in the earlier stages, owing to the ease with which the object could be cast upon it.

Mr. Inman

said the result of this discussion had been to show the extensive ignorance of the profession as to the cause of squint. It seemed to him that the failure of a hypothetical fusion centre was becoming more and more discredited. Two years ago it struck him that none of the explanations was adequate. One of the points which emerged from the debate was that the owner of the defect had been left out of consideration. He had thought that the child might have developed a squint to replace an emotional stress. The profession accepted without demur the deliberate suppression of the vision: why not accept the theory of the deliberate though unconscious production of a squint? The latter had some of the characteristics of a hysterical lesion. In the great majority of cases there was harmonious working of the two eyes until the age of two or three. No special strain of the eyes occurred at that age, yet gradually or suddenly binocular vision broke down. It was true that hypermetropia was usually present, but it was rarely absent in some degree in children. There was no relation between the amount of hypermetropia and the degree of squint, and it was the common experience that high hypermetropia was very frequently found without even a tendency to deviation. Then, again, the squint was not constant. It often varied with the emotional state of the child, especially about the time of onset. It might disappear altogether for a season. The failure of a fusion centre would not explain these and other phenomena, such as, for instance, the fact that the child practically never developed a divergent squint, the reason being that it was easier to converge at will than to diverge. It was useless asking a child why it squinted, and he had looked for something which would give direct evidence. He found among squinters an unusually large proportion of left-handed persons and stammerers. If absent in the patient these abnormities could frequently be found in the brothers or sisters or other near relatives.

He had had patients who had suffered from all three conditions. The proportion of left-handed people in the general population had been given as from 2 to 4 per cent.; among squinters and their families it was far greater. He remembered Dr. Henry Head speaking of the alternation of the habit of stammering and left-handedness. A classic instance might be cited. A group of fourteen slightly mentally defective children (in whom left-handedness and squint were more common than in the normal child) was taken. They were all left-handed, and were made to use the right hand. As a consequence eleven of them developed a stammer. Thus it seemed that these two conditions were interchangeable. They had been explained by psychologists as due to want of harmony with the parents. The speaker had evidence to show that squint might arise in the same way. It had been very well said that beneath every hysteria or neurosis lay an unworthy motive. It was clear that a child gained at any rate much consideration and attention from its parents. Mr. Harrison Butler said that he had found squint more prevalent in the so-called lower orders, where presumably emotional "kinks" were more likely to happen. Such a view might explain the tendency of a squint to get well spontaneously towards adult life. Squint in mature individuals was comparatively rare, and this could not be accounted for by the amount of curative treatment carried out by the profession. Moreover, several speakers that day had expressed their disappointment in the result of measures most accredited for the cure of the deformity. Eyes were put straight, but often would not remain straight. He suggested that members of the Society should investigate further along these lines. The collection of a large number of cases would lead to accurate generalisations.

Mr. R. R. Cruise

brought forward and demonstrated an instrument which had been of considerable service to him for the education

of children who had imperfect fusion. He, like so many others, had been much impressed by Mr. Worth's amblyoscope, but he had found that, in his hands at least, its capacity was limited, and that it was a somewhat dull instrument; children and adults with imperfect fusion found exercises with it a dull performance. He (the speaker) therefore had had the stereoscope (shown) made. It consisted essentially of an ordinary stereoscope, with a frame, placed before the eye-pieces, carrying a pair of prisms which could be rotated through 180 degrees. Images or pictures could be approximated or separated by turning a screw, which rotated the prisms to an appropriate degree of convergence or divergence in each particular case. It was his practice to get as much fusion and amplitude out of patients as he could with the amblyoscope and then to proceed with his own instrument. Ordinary stereoscopic pictures can be used, and if a desire for fusion existed it could be effected at the patient's own angle. He wanted something which would encourage amplitude of fusion, as there were many people in whom it existed imperfectly. A screw arrangement would alter the relation of the image seen. It had been useful in cases of insufficiency with a wandering divergent eye. He had been using this instrument for the last twelve years. He had an instructive case, which he started off with Worth's instrument twelve years ago. The boy was æt. 5 years, and the speaker educated him with the amblyoscope and got fusion-sense; the squint was 35 to 40 degrees; it was this boy's case which led Mr. Cruise to have this instrument made. One was bought for the boy to exercise at home. He operated upon that boy six months ago, and he now had a perfect result. All the time he had kept up the boy's fusion-sense by occasionally using this stereoscope. He now had straight eyes and excellent fusion. That was the only case he had had the opportunity of following up on these lines. It constituted an argument in favour of those who held that the correct way to treat squint was to educate the fusion

centre, so that when it was educated and perfect there was a reason for the eyes remaining straight owing to the educated desire for binocular single vision.

With regard to the operation employed, for many years he had had no hesitation in tenotomising, and he would like to impress upon those who were nervous about tenotomising that the bogey of divergence was greatly exaggerated, and need not be feared if the procedure were adopted which he had carried out for a long time. He first did an advancement, then tenotomised, dissecting up conjunctiva to the caruncle, so that it was free over it. As one picked up the conjunctiva one could see the strands leading to the caruncle from the tendon sheath. Before doing tenotomy one passed a suture threaded on two needles through the tendon from the ocular surface; the needles were then passed again beneath the conjunctiva to emerge a little distance apart at the limbus. Thus one had a retention suture to hold the tendon in position. One then sewed up the conjunctival incision, leaving the retention suture lying loose beneath the conjunctiva. One could draw on that suture and hold the tendon in whatever position desired. Owing to the freeing of the caruncle from the tendon there was no slipping back of the caruncle or unsightliness at the inner canthus. In addition, he had for the last few years flooded the eye two or three times with one of the silver colloid preparations; this prevented sepsis of sutures, which in past years had been a cause of sutures cutting through.

Mr. E. H. Stack

said he was not convinced on the question of sutures slipping out; they might slough out. He thought that they might pull through the tendon. A few days after the operation the lump, which was obviously close up to the cornea, had slipped further back, but with very little effect on the final result. He seldom did tenotomy of the internal rectus alone, but before beginning the operation

he turned the eye outwards and made an incision fairly far back, through the conjunctiva to the muscular part of the internal rectus, put a needle under that, and drew a thread through, leaving it there while he did an advancement on the other side, leaving the muscle there for the patient to pull the eye well over, as he was asked to look over to the nasal side. When he had finished advancement on the other side, he pulled on the stitch and cut it out, *i. e.* he cut through half or three-quarters of the muscle; that took only a moment at the end of the operation. It did just paralyse or hamper the internal rectus afterwards, without making any difference in its length. He thought that it helped, and enabled one to get the pads off the eyes earlier than otherwise. He wished to thank Mr. Bishop Harman for the interesting things he had said about heterophoria in young children. It was another point in the argument which he had strongly urged, namely, that there ought to be a routine examination of all children before the age of four; *i. e.* it was necessary to get at children before they started school, and also to get at children of the richer classes, who seldom consulted the ophthalmic surgeon before a squint had developed. He thought the provision of prisms or spectacles would do very much more in saving those which could be corrected, if the children could be got at before four years of age.

Mr. Worth (in reply)

said time would not permit of a detailed reply to every speaker; moreover, the effort would be tedious to the meeting. With regard to fusion training, he had often wished that he had never talked about fusion training at all. He practised it himself, but for the last twenty years he had had to explain to somebody—on the average once a week—the limitations of fusion training, to impress the fact that one must not expect too much from it. The

limitations of fusion training were very great—greater than he at one time thought. The child must be quite young, perhaps four years of age, certainly not more than six years; he had never had a success beyond six years of age unless the patient had some fusion before and he had been able to improve it. By various methods one could improve fusion later, but not unless it existed to some extent before. It needed infinite patience, and one required plenty of time. It was not of much use to prescribe exercises at home unless the child had a particularly intelligent mother. That further limited the application, because it was not always possible for the surgeon to spare the time, or the parents to afford to pay the fees for frequent visits. But in the small proportion of cases which were suitable for fusion training he was certain one could get results which were not obtainable by any other means.

With regard to amblyopia *ex* anopsia, there were only two ways of arriving at the truth in anything: one was by investigating the question for oneself and considering the results in one's own experience; the other was by studying and weighing the evidence collected by others. It was difficult to conceive how anyone who had employed either of these methods could have any doubt about the question of amblyopia *ex* anopsia. Apart from the evidence of statistics, one's ordinary experience in the treatment of squinting children and in overcoming amblyopia in the squinting eye provided such evidence as could scarcely be doubted. Amblyopia could only be acquired or cured while the child was young. He had never seen amblyopia acquired to any considerable extent after six years of age, and usually the child must be younger than that when one tried to cure amblyopia. It was not so much the child's actual age as the proportion of its life during which the unilateral squint had lasted. If it had existed during half the child's life or more, usually the amblyopia was incurable. He had seldom failed to get perfect sight with correction, or

nearly perfect sight, in which the squint had lasted less than a quarter of the child's life.

Another question concerned the methods of trying to deal with amblyopia *ex* anopsia. He did not wish to be dogmatic, but in his experience the only thing which was of any good after fixation was lost was *continuous* occlusion of the fixing eye with a pad and strapping. One speaker referred to doing this by a pad stitched to the spectacle frame. How would that be done? Would the patient sleep in his spectacle frames? When he had an eye strapped up, the strapping was usually only removed once a week. Ventilation was allowed through a hole in the middle of the strapping, and that eye was not allowed to see the light, except such a small amount as might filter through the pad and the lids.

Mr. Harrison Butler had said that he came across a certain book on squint some years ago, and soon discarded it, and then went on to say, in discussing the aetiology of squint, that the fusion centre would not have much to do with it because he had seen some squinters who could pass Hering's drop-test. But if, before throwing away that book, Mr. Harrison Butler had taken the trouble to read it, he would have found that the fact that some squinters could pass Hering's test was mentioned and the reasons for it discussed.

On the question of operation, except in cases in which obviously no good could be got from optical correction—for instance in emmetropia, or when it was unlikely that glasses could have any further effect—he did not remember a case in which he had operated before the patient had been under observation for a year. His great objection to tenotomy—the reason he had not done it for more than fifteen years—was not so much the danger of divergence; one could correct that; but because one could not know what he was going to do. If one did tenotomy, one did not know what the effect would be, and it rendered anything in the way of accuracy impossible. And though he did not wish to boast of his results, he was in the

habit of saying beforehand what the result of his operation would be, and he would not feel he could do that if he had done tenotomy.

There was a remark of Mr. Ballantyne's with which he entirely agreed: one could not operate by measure. It was a matter of judgment rather than any mechanical element, because there were so many other factors which must come in; one must study the squint and do what one's experience led one to conclude was necessary.

Mr. Ballantyne (in reply)

said he was sorry if he did not mention the particular operation he did himself. His two favourites were Worth's advancement and Worton's tenoplication operation. He had no predilection in favour of any particular operation. He had established a routine in his own work, and that had much to do with the success one achieved. He had done Mr. Harman's operation, but perhaps he had not done justice to it in the past.

In regard to what Mr. Worth said as to not being able to estimate the result of an operation in advance, his (the speaker's) point was that this applied more the younger the patient. As the patient got older the squint became more of an anatomical deformity, and one could calculate beforehand what result one would obtain by an operation.

He had been interested in Mr. Harman's references to heterophoria, and particularly hyperphoria, as a factor in the causation of squint. He did not mention it in his own remarks, but he had had one or two cases in which he thought there was reason to believe that the presence of hyperphoria would produce a difficulty in getting true binocular vision, and it might have been a factor in causing convergence. If the hyperphoria could not be corrected, it would allow the esophoria to pass into permanent squint.

He thought the question of the proportion of cases in which heterophoria had an influence in the causation of squint was a very important one, and that it deserved investigation. It was difficult, in young children, to investigate these defects of muscle balance.

V. DISEASES OF CONJUNCTIVA AND CORNEA.

1. *Case of symmetrical encroachment of the conjunctiva on the corneal margin.*

By D. J. Wood.

In volumes xxiv and xxix of the *Transactions of the Ophthalmological Society* two cases have been described by Mr. E. T. Collins of symmetrical encroachment of the conjunctiva on the corneal margin. I have had a similar case recently which seems worthy of record, as I know of no others.

M. M. Laubscher, an old Dutch farmer, was sent to me at the end of June, 1920. His doctor reported that six weeks previously he had treated him for a cellulitis at the root of the nose on the left side. The lids were closed and the eye looked red. After simple treatment, mainly moist heat, pus escaped from the inflamed focus, and in about two weeks it healed. The eye remained red, however, and he was sent to me.

The left eye was congested, the cornea dull and its edge opaque. More careful examination showed that the corneal margin was covered by a ring of conjunctiva from 2 to $2\frac{1}{2}$ mm. wide. It was semitransparent, so that iris details could be seen mistily through it. The edge was sharply defined, and a little raised. The conjunctival blood-vessels were continued into it. The cornea was curiously dull, and was covered by a series of fine reticulated grooves unlike anything I have seen. This became more obvious as one looked at it, and the cornea became dry. Fluorescein stained the reticulations brightly and the rest of the cornea faintly.

The cornea was to a considerable extent anæsthetic, and the loss of sensation extended for an inch or so above, and to a less extent all round the eye.

There was little pain, but the drying of the eye caused discomfort, and the patient kept it shut. There was no ptosis or motor failure. Tension was normal, the pupil acted sluggishly, the iris where visible was bright. No fundus details were visible on account of the corneal haze, and for the same reason vision was bad and got worse as the eye was kept open. There was no doubt that the secretion of tears was diminished.

On a subsequent visit I ascertained that the adhesion of the encroaching conjunctiva was slight, and that a fine probe could be used to separate it from the cornea. In view, however, of the anæsthetic condition I did not interfere more than was necessary either in this way or in treatment. Indeed the only thing which did not cause discomfort was normal saline, and nothing seemed to make much difference to the redness.

I found after some search the two cases by Mr. Collins and it is clear that all are similar. In my case, however, there is no doubt that the trouble was not congenital but followed the cellulitis, and the ptosis recorded by Mr. Collins was absent. My impression is that the condition was related to the partial anæsthesia, which in turn was due to the cellulitis. The reticulation of the cornea was doubtless due to the dry state of the cornea, but it remained constant.

Unfortunately I allowed the patient to return home and he has not kept his promise to return, so that I cannot give further progress.

2. *Recurrent tumour of conjunctiva.*

By A. C. Hudson.

George G—, æt. 49 years, coal carman.

October 18th, 1917 : Left eye. Fleshy tumour of lower

outer bulbar conjunctiva, the size of a split-pea, with faint pigmentation in upper and lower periphery. Large blood-vessels passing to and from it: freely moveable over sclerotic. Tumour noticed one year, getting larger.

October 25th: Blood-vessels ligatured well away from tumour, and tumour removed with neighbouring conjunctiva.

February 16th, 1921: Recurrent pigmented tumour of conjunctiva, probably adherent to external canthal ligament.

March 3rd: Tumour removed mainly by galvano-cautery incision through neighbouring healthy tissue.

(Sections of primary and recurrent tumour shown.) The primary tumour shows the characteristic features of a congenital nævus: the "nævus cells" are, however, undergoing proliferation and invading the neighbouring tissues in the manner of a sarcoma. In rare instances the cells contain brown pigment.

The recurrent tumour is a sarcoma, composed of polyhedral cells, some of which contain several nuclei. The pigmentation appears to be hæmatogenous.

3. *Adherent leucomata treated by operation.*

By A. C. Hudson.

John D—, æt. 13 months.

November 11th, 1920: Right and left extensive scars of perforation of cornea from ophthalmia neonatorum, with anterior synechia of entire pupillary border, abolition of anterior chamber, and increased intraocular pressure. Right cornea becoming staphylomatous.

December 2nd: Right corneo-scleral trephining.

January 6th, 1921: Left corneo-scleral trephining.

February 28th: Left corneo-scleral trephining; right iridotomy with Graefe knife.

April 11th: Left iridotomy with Graefe knife.

May 6th: The intraocular tension appears to be

satisfactory in each eye. There is an artificial pupil permitting good fundus reflex, and a useful degree of vision, as far as this can be tested, in each eye.

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4. *Reticular opacity of the cornea.*

By Charles Goulden.

Patient, female, æt. 23 years.

First seen on March 1st, 1921, complaining of redness of the left eye. This the first attack. No complaint of defective vision.

R.V. $\frac{6}{12}$ — 0·50 D. sph. = $\frac{6}{9}$. L.V. $\frac{6}{24}$ — 1 D. sph. = $\frac{6}{9}$.

There was ciliary injection of the left eye.

In each cornea a grey, irregularly lattice-shaped opacity generally distributed in the superficial part of the substantia propria of the cornea. The surface of the cornea unaffected and not irregular.

Deeper to this opacity, and well appreciated with a binocular loupe, a generally distributed opacity of the cornea, brownish in colour, the individual elements sharply defined, branched and somewhat bone-corpuscle-shaped.

No signs of inflammatory infiltration of the cornea.

The ciliary injection disappeared in a week with the use of atropine.

No similar opacity in the cornea of the mother or brother.

Probably similar to a case shown by Mr. Collins (*Trans. Ophthal. Soc.*, vol. xix, p. 30).

The President said that, as far as his recollection of such cases went, evidence as to their being of an inflammatory nature was not common. In the case in question it may have been coincidence rather than an inherent part of the disorder.

VI. DISEASES OF THE UVEAL TRACT.

1. *A case of cyclitis accompanied by swelling of parotid glands and paralysis of cranial nerves.*

By A. Maitland Ramsay, M.D.

The case that I am about to describe is unique in my personal experience, and in my search through ophthalmic literature I cannot find much that has been written directly bearing on the subject. I have brought the case before the Society in the hope that some of the members may be able to throw more light upon the condition than I have been able to do.

The patient, Miss G. B—, æt. 31 years, was referred to me by Dr. Mackenzie Anderson on March 1st, 1920. She said that she always enjoyed good health and was keen on outdoor sports. She suffered from the usual diseases of childhood and when six years old the cervical glands on both sides became enlarged. The enlarged glands were removed by operation, and there has been no recurrence. The linear scar of the operation wound is quite healthy, and so inconspicuous that it must have healed by first intention.

Miss B— suffered a very severe bereavement in 1915, and in order to try to occupy her mind she busied herself very strenuously with various forms of war work. She knew that she was overtaxing her strength, but she says that she considered herself so strong that she made light of her feelings of fatigue, and disregarded all advice to take a restful holiday. In January, 1920, she went to Turnberry to play golf; so far as she knew she was quite well. The weather was wet and cold, but she did not suffer on

that account, and says that she was thoroughly enjoying the holiday, when, without any warning, the present illness began. She went to bed as she thought quite well, but when she got up on the morning of January 7th she noticed that her lower eyelids were puffy and her ankles swollen. She had no headache or nausea or shivering, and says she had a good appetite for breakfast and felt in her usual health. She was, however, so much perturbed by the sudden occurrence of œdema of her face and ankles that she returned to Glasgow to consult Dr. Mackenzie Anderson. He made a thorough clinical examination, but failed to discover any abnormality in the urine or in the circulatory, respiratory or digestive system to explain the symptoms. The patient herself insisted that she felt no discomfort. There was a suspicion that there might have been a dietetic error, but no evidence in support of that supposition was to be obtained. The œdema, however, persisted, but as it caused no inconvenience Miss B— felt no hesitation in keeping a promise to visit a sister in Liverpool, where she spent five strenuous days. On her return to Glasgow it was discovered that her legs were swollen as high as the knees, and that an eruption of erythema, accompanied by localised swellings, and having the appearance of erythema nodosum, had appeared over the shins. The eruption was not painful or tender to pressure, but whenever the skin was stroked or touched lightly, as, for example, when the nightdress or the bedclothes rubbed against it, a very disagreeable sensation was induced. There was at this time no eruption on any other part of the body, but the skin over the chest was unduly sensitive to touch and there was also very severe intercostal pain. The patient's discomfort was now so acute that she was kept in bed, and after ten days the œdema disappeared from the face and ankles, but tended to persist over the shins and the dorsum of the feet. Rest in bed, however, gave no relief to the intercostal pain, which became neuralgic in character and was at times so severe that it caused great

restlessness, and seriously interfered with sleep. It was always worst in the recumbent posture, and was not appreciably relieved by remedies. Aspirin was the most successful, but the respite from suffering was of brief duration even after large doses of the drug had been taken.

The erythema, at first confined to the skin over both shins, now began to extend. It soon covered both thighs, and the lower part of the body as high as the waist and both arms. The eruption appeared in large blotches of deep reddish-brown colour accompanied by localised swelling. The whole of the skin affected was exceedingly sensitive, consequently the increase in the distribution of the rash added greatly to the patient's sufferings. On February 2nd—that is, rather more than three weeks from the onset of the illness—the left parotid gland began to enlarge, and a week later the right became similarly affected. The swelling of the parotids was not great, and only lasted about a fortnight. It was unaccompanied by pain, or by increase of temperature, or in the rate of the pulse. Observations of temperature and pulse had been taken regularly from the onset of the illness but no sign of fever was ever detected.

The œdema, the cutaneous eruption and the intercostal pain continued without any appreciable change in the patient's condition until February 18th, when without pain or any kind of warning the sight of the right eye became dim, and five days later the left became similarly affected. The eyes were not bloodshot, but were tender and readily watered on exposure to light, and sight was blurred. The patient was, however, able to read and sew until February 26th, when vision suddenly became so dim that everything was seen through a thick mist. On March 1st the state of the eye was as follows: photophobia and lacrymation were slight. There was neither pain nor tenderness on pressure. In both eyes there was deep livid pericorneal injection, numerous spots on the posterior surface of the cornea, discoloration of the iris, irregularity of the pupil and a deep anterior chamber.

Intraocular tension was not increased, the field of vision measured by hand was normal in extent, and there was no impairment of the colour sense. The details of the fundus were seen very indistinctly with the ophthalmoscope through a dense fog, caused partly by keratitis punctata, but chiefly by numerous dust-like opacities which impaired the transparency of the vitreous humour. No gross pathological lesions were seen in the optic disc or the retinal blood-vessels, or in the choroid or retina. The visual acuity tested by Snellen's types was $\frac{6}{12}$ with the right eye and $\frac{6}{18}$ with the left. A solution containing 1 per cent. atropine and 2 per cent. cocaine was prescribed, and tinted glasses were ordered to protect the eyes from bright light. The pupils dilated quickly and fully after the instillation of the drops and became circular in outline, but sight steadily deteriorated, and on March 24th was reduced to $\frac{6}{24}$ Snellen. The drops caused no increase in intra-ocular pressure, and the steady failure of vision was commensurate with the increasing opacity of the vitreous.

On March 14th paralysis of the left facial nerve suddenly developed. The distortion of the face was noticed in the morning on awakening from sleep. For some days, however, before the palsy occurred, the patient had complained of a peculiar sensation in the skin of the left side of the face. She said that it was neither a pain nor a want of feeling, but that when the skin was touched ever so lightly, or even when there was a movement in the air of the room, the whole of the left side of the face felt as if it "had been frozen." Vision now began to fail more rapidly, and in a few days the patient could barely distinguish a hand held between her eyes and the light from a window, and it was noticed that she seemed to see more distinctly on the temporal aspect of the field of vision. She was still able to distinguish colour, and took pleasure in trying to recognise the flowers which friends were constantly sending to her.

About March 20th it was noticed that the patient was speaking through her nose. For some days previously

she had been complaining of a peculiar sensation in her throat and of difficulty in swallowing. Six days later fluids regurgitated through the nose and the soft palate was completely paralysed. On the same day that the soft palate became paralysed sight further failed in the right eye. The patient said that during the night it had become quite blind. Testing with the small lamp of an electric ophthalmoscope showed that while a bare perception of light was retained in the temporal field of vision no light was seen on the nasal portion. No red reflex was present in the pupil and it was not possible to illuminate the fundus with the ophthalmoscope, but there was no sign that hæmorrhage had occurred into the vitreous humour.

By the end of March the paralysis of the left side of the face had disappeared, and fluids were swallowed without difficulty, but the patient still complained of the peculiar frozen feeling of the skin over the left side of the face. It was considered that change of air would be helpful, so on April 3rd she was taken to Stirling. She did not suffer in any way from the journey, and Dr. MacFadyen, whom she saw shortly after her arival, was quite satisfied with her condition. A few days after her arrival, however, it was discovered that she was passing mucus from the bowel. The colitis was slight and gave rise to no symptoms, but it persisted for several weeks. It is not certain that the colitis was a fresh development in the course of the illness, because up to the time of going to Stirling the patient had always been in the habit of going to the lavatory when her bowels acted, and consequently there had been no opportunity to examine the stools.

On April 16th paralysis of the right facial nerve developed. Its occurrence was preceded by cutaneous sensations similar to those experienced on the left side. The palsy lasted for about three weeks and disappeared gradually, and at the same time the intercostal neuralgia, one of the earliest and most troublesome symptoms of the case, began to lessen. About this time also the eruption

on the skin commenced to fade, and in the course of a few weeks gradually disappeared.

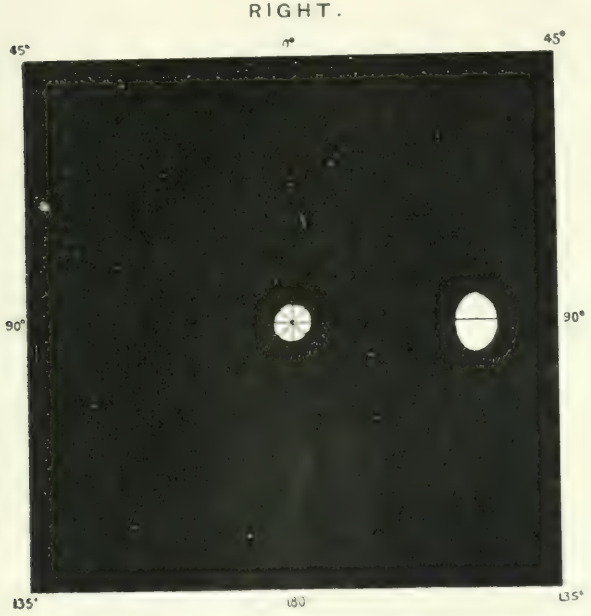
Great difficulty had been felt all along regarding the aetiology of the disease, for although it was considered to be either infectious or metabolic no proof could be produced in support of either hypothesis. About the middle of April, therefore, Prof. Carl Browning was asked to make a complete bacteriological and serological investigation of the blood, urine, fæces, and of the secretions from the nose, throat and conjunctival sac. The result of the examination showed "no evidence of a blood infection or of the presence of any disease-producing organism." That report, although it could not be regarded as conclusive, strengthened the impression, formed from observation of the clinical features of the case, that the symptoms were due to some form of deficiency disease—not necessarily to a food deficiency, as is seen in beri-beri, but rather to a deficiency of metabolism or to a failure in normal physiological regulation of function. Acting in accordance with the theory that all internal secretions are regulated and controlled by the thyroid gland, thyroid extract was prescribed. The initial dose was one and a half grains twice a day, but the patient proved to be very sensitive to the action of the drug, and after two days felt so ill that the dose was reduced to half a grain once a day. Whenever the dose was reduced all unpleasant symptoms disappeared, and the patient began to feel a sensation of well-being—an experience she had not had since the early weeks of the illness. For several weeks the ocular symptoms had seemed to remain stationary, but within a week after thyroid extract had been prescribed in half-grain doses improvement in sight began to be noticed. Although to all intents and purposes quite blind, the patient was in the habit of going for a daily motor run for the sake of her general health. About a week after the thyroid treatment had been begun she was out one afternoon for her usual drive, and was astonished to find on the homeward journey that in a vague way she

was able to see the form of houses, trees, vehicles, etc., as she passed them on the road. From that time onwards recovery of sight, although slow and gradual, has been uninterrupted. Whether or not the amelioration of the symptoms was due to the thyroid cannot be determined with any certainty, but a decided change for the better undoubtedly occurred shortly after the drug had been administered. The medicine has, therefore, been continued, and since the end of May no other drugs have been given. It is worthy of mention, however, that the menstrual period, due on January 25th, was delayed until February 16th, and from that time there was amenorrhœa until May 24th, when the menses became re-established, and since that date menstruation has been regular.

During the months of June and July there was steady gain in general health, accompanied by improvement in the sight of the left eye, but the vision of the right eye remained very defective. On August 3rd there was only perception of objects on the temporal aspect of the right visual field, and it was doubtful if light was seen on the nasal aspect. The media in both eyes were still very hazy, but with the ophthalmoscope it was now possible to see some details of the fundus. The right optic disc was cupped deeply at least 4 D. The cupping implicated the whole disc, whose appearance, together with the arrangement of the retinal blood-vessels, was characteristic of glaucoma. The left optic disc was pale, but was only slightly excavated. At no time during the course of the illness was intra-ocular tension found to be increased, either when estimated by the fingers or on any occasion when Schiötz's tonometer was employed. The deep cupping of the right optic disc is doubtless due to prolonged uveitis, to hypersecretion from the ciliary body, and to weakening of the ocular tissues. The disease was inflammatory, and in that important respect differed from glaucoma. It is, moreover, very doubtful if its course would have been changed for the better by any of the operations advised for the relief of genuine glaucoma.

Nevertheless had any increase in intra-ocular tension been detected it is very likely that an attempt would have been made to reduce it by operation. It is not at all certain, however, that the result would have been satisfactory, because surgical interference might have aggravated the uveitis. On the whole, my opinion is that the patient's

FIG. 26.



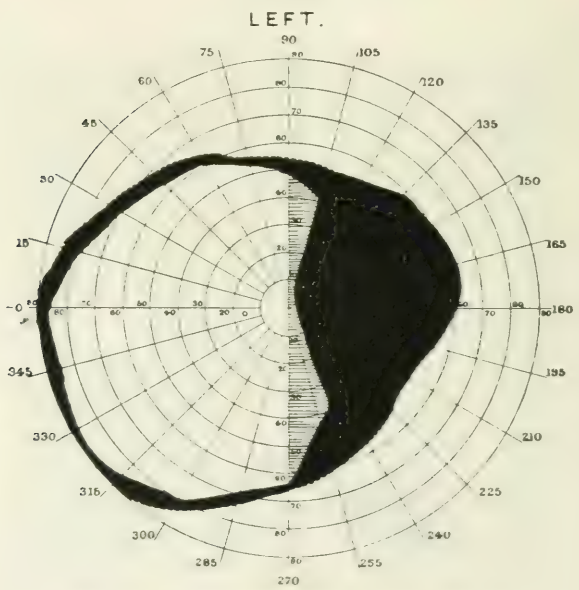
Miss B—, August 3rd, 1920.

chance of recovering sight has not been lessened for want of a surgical operation. The persistence of the colour-sense after vision as a whole was very greatly reduced encouraged the hope that the optic nerves were not suffering unduly. The possibility of such a serious complication had always been considered, but cloudiness of the vitreous made ophthalmoscopic examination impossible, and want of sight prevented an investigation of the patient's light-sense. An examination in March with Perceval's

discs has demonstrated that while in the right eye there is little change in the light minimum the light difference is very much increased. Had it been possible to make that observation earlier in the course of the disease a more accurate prognosis might have been given.

From the onset of the eye symptoms a $\frac{1}{2}$ per cent.

Fig. 27.



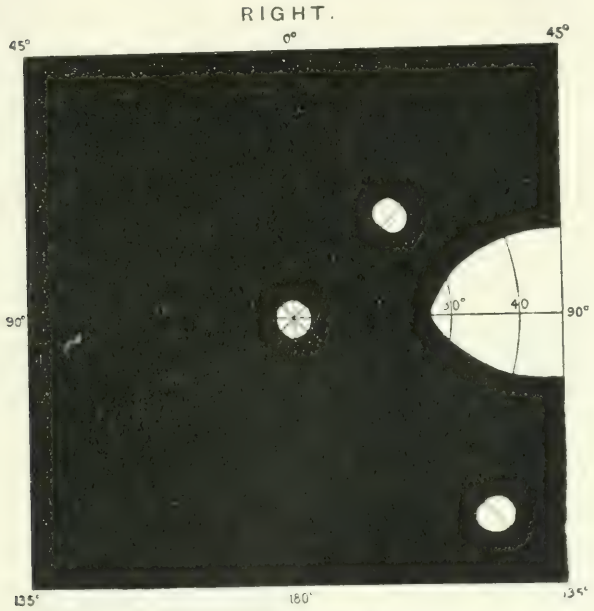
Miss B—, August 3rd, 1920. 2 mm. object.

aqueous solution of atropine was used to keep the pupils dilated and prevent the formation of posterior synechiæ. At first it was necessary to instil the atropin every day in order to keep the pupil dilated, but as the signs of congestion passed away the mydriatic was instilled less and less frequently. The size of the pupil was the guide to the use of the drops, which were only instilled when it was necessary to induce dilatation. When, however, it was discovered that the right optic disc was cupped, pilocarpine in 1 per cent. aqueous solution was substituted

for atropine. Full contraction of the pupil was readily induced, but the miosis only lasted for a few hours, and in order to keep the pupil contracted it was necessary to instil the drops three times a day.

The visual acuity of the left eye continued to improve, and in October equalled $\frac{6}{9}$ Snellen aided by $-\cdot 75$ D.

FIG. 28.

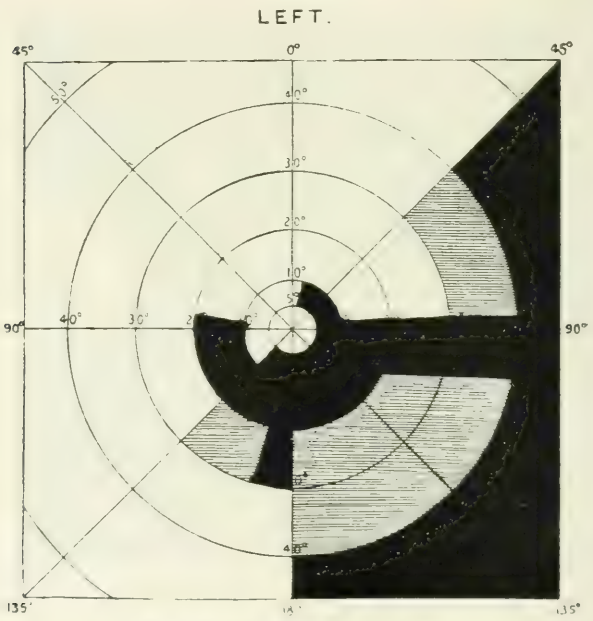


Miss B—. August 31st, 1920.

spherical lens. In August attempts were made to map the field of vision, both with the ordinary perimeter and by Peter's campimeter. The test object employed was 2 mm. in size. The earlier observations were conducted with considerable difficulty. It was found much more difficult to measure the peripheral field than the central area, and the earliest charts are not reliable. As the sight improved, however, the whole of the field of vision was more easily examined, and the patient's observations

and statements regarding her sight were usually confirmed by the results obtained by perimetry. For example, even after vision in the left eye was $\frac{6}{6}$ Snellen, she said that she was unable quickly to recognise friends whom she met on the street, because, although there was an area in the centre of the field in which everything was clear and bright, yet there was a fogginess surrounding this central

Fig. 29.

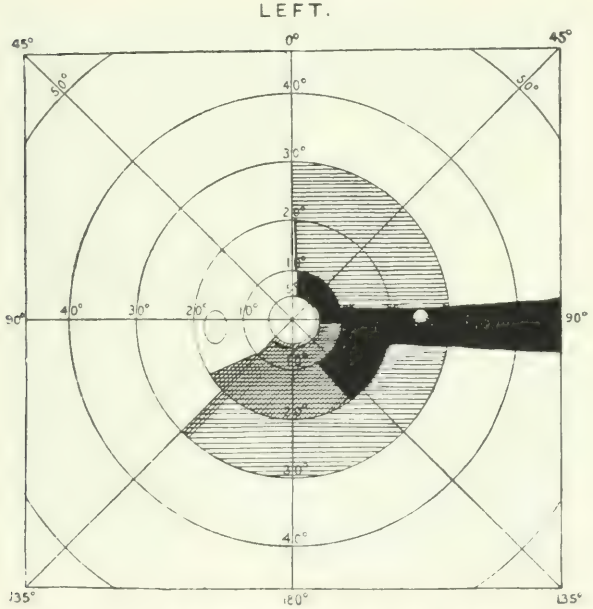


Miss B—. November 4th, 1920.

spot which prevented her from seeing properly. A study of a series of charts of the field of vision explains the patient's disability. These charts demonstrate that recovery of sight took place partly by an extension of the central area of vision, and partly by the appearance in the peripheral blind area of what may be called "islands of vision," which gradually increased in size, and in some instances coalesced. In that way the blind area lessened as the

seeing area increased. A further and more detailed study of the charts shows that the loss of sight has been due to two causes: first, to the implication of the choroid in the general uveitis; and second, to atrophic changes in the optic nerve itself. That is the explanation of the more rapid recovery in the left eye, the loss of sight in which was due to choroiditis rather than to atrophy of the nerve.

Fig. 30.



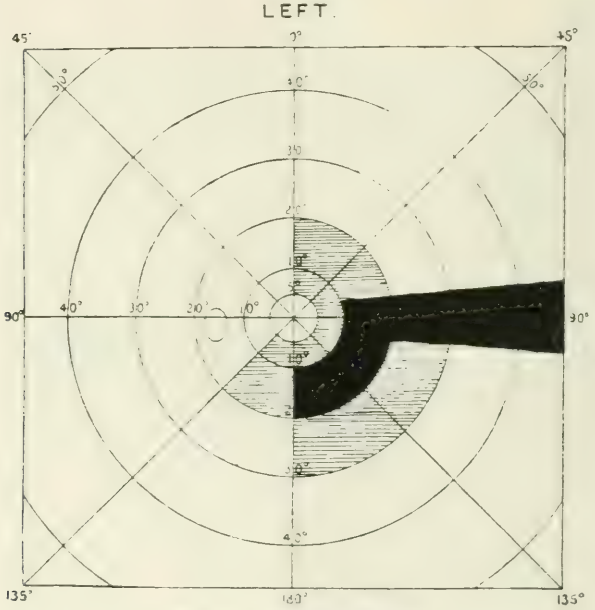
Miss B—. December 14th, 1920.

In the right eye, on the other hand, changes in the nerve predominate, consequently recovery in that eye has been slow and partial. Nevertheless in that eye also the appearance of islands of vision in the blind area shows that the impairment of sight has been partly due to the uveitis. These facts illustrate the help in prognosis to be gained by a careful study of the field of vision.

In the *Transactions of the Ophthalmological Society*

for 1917, Mackay reports a case of uveo-parotitis with irido-cycloplegia, and in addition he has appended a bibliography, which as far as I have been able to discover contains all the references to the literature of this subject. All the cases published agree in so far that there have been parotitis, uveitis, and implication of cranial nerves,

FIG. 31.

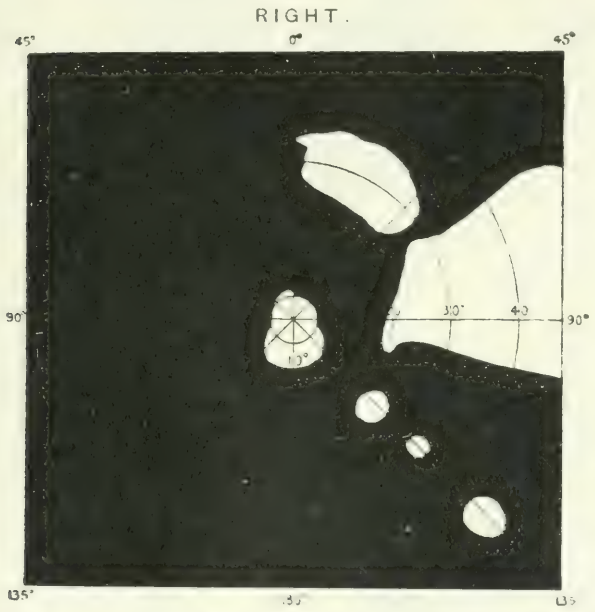


Miss B—, April 15th, 1921.

but there is no uniformity in the order in which those different signs have appeared. Miss B—'s case, moreover, presents features which are not present in any of those previously reported. Neither mumps nor diphtheria can be considered as a factor in its ætiology, but the occurrence and the persistence of a cutaneous eruption show that it has been due to the action of a systemic cause, which up till now has not been discovered. The implication of the optic nerves, which is the most serious feature of

Miss B—'s case, has been due in all probability to the severity of the uveitis rather than to the action of a specific toxin acting directly on the nerves themselves—a process in all probability similar to what occurs in some cases of progressive myopia. There can be no doubt, however, that the toxin had a special affinity for nerve

Fig. 32.

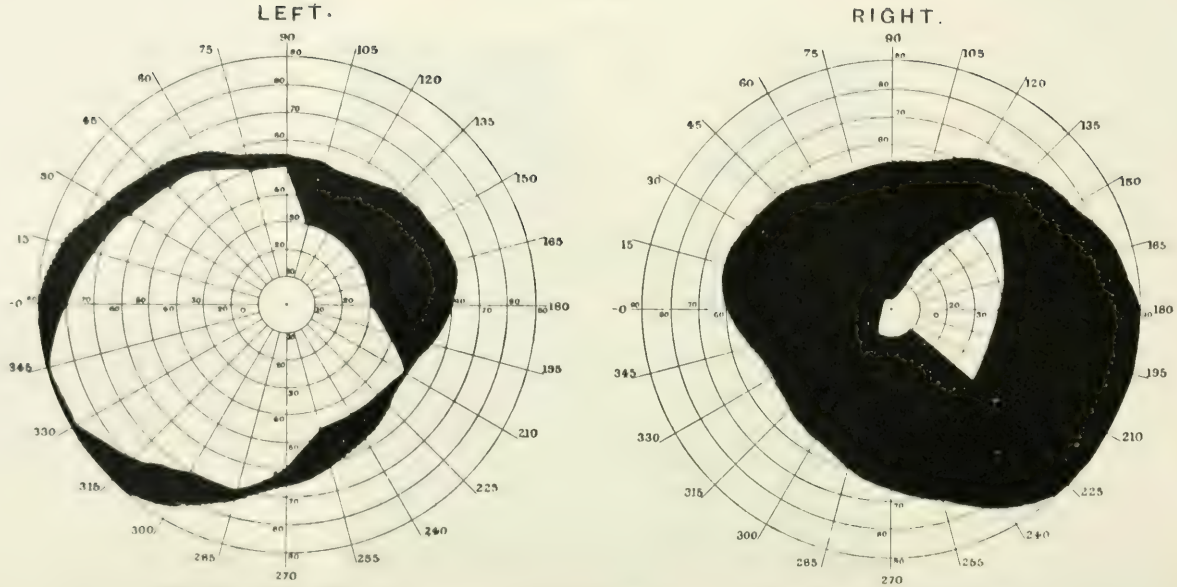


Miss B—, April 15th, 1921.

structure, and may have contributed to the weakness of the nerve, and rendered it less able to resist what seems to have been a normal intraocular pressure. The most serious relapses in the eye condition occurred, moreover, about the same time as the facial and palatal nerves became affected.

Another distinctive feature in Miss B—'s case is the occurrence of the cutaneous eruption. It preceded the appearance of the ocular symptoms by rather more than

FIG. 33.



Miss B—, April 15th, 1921. 2 mm. object. Miss B—, April 15th, 1921.

a month. Osler has described various eye lesions in connection with purpura and allied erythematous conditions of the skin, including erythema nodosum, but they were always characterised by the occurrence of intra-ocular or extra-ocular hæmorrhage. As far as I have been able to determine bleeding was absent in Miss B—'s case. Nevertheless, there is no doubt that the cutaneous eruption and the ocular symptoms are correlated, in so far at least that whenever the rash on the skin began to disappear the congestion of the eyes simultaneously lessened.

I have to thank Dr. A. Garrow for the charts of the field of vision.

FURTHER NOTE BY GEORGE MACKAY, M.D., EDINBURGH, ON THE CASE OF "UVEO-PAROTITIS WITH IRIDO-CYCLOPLEGIA," PUBLISHED IN THE SOCIETY'S *Transactions*, VOL. XXXVII, 1917.

The intimation on the programme for our meeting this year of a paper by Dr. Maitland Ramsay on "A Case of Cyclitis associated with Swelling of the Parotid Glands," recalled my attention to the communication which I made to the Society in May, 1917, on "A Case of Uveo-Parotitis with Irido-Cycloplegia."

I had not seen this patient again for nearly four years but at my request she called upon me a few days ago (May 1st, 1921). She informed me that she had kept quite well and occupies the same domestic situation as a table-maid. That she had not been conscious of any return of inflammation in her eyes, and thought there was little change in her vision since her recovery in 1917. That her main difficulty now is in seeing to sew black material in an artificial light, due presumably to a poor light-sense.

On examination I found that all traces of deep punctate keratitis have now disappeared but two or three fine tags of posterior synechiæ remain at each pupil border. The pupils are circular but still rather wide. Facing the

light the right is fully 5 mm. in diameter, the left about 4·5 mm. Both are still immobile to light, but contract quite appreciably on convergence.

This makes it doubtful whether the immobility of the pupils to light can be due to the synechiæ, but of course a reflex light stimulus may not act as powerfully upon a sphincter iridis as a voluntary motor impulse associated with convergence of the visual axes. The possibility of the loss of light reflex being due to a central and not a peripheral palsy must also be considered but is difficult to determine. The return of accommodative power in M. R—'s case is demonstrable by the shadow test, and by the reading of diamond print by either eye up to at least 10 in. from her face.

During the past four years this patient has developed a little myopic astigmatism.

Unaided R.V. $= \frac{6}{12}$ partly, with — 1 D. ax. vert. $= \frac{6}{6}$ partly.

Unaided L.V. $= \frac{6}{12}$ partly, with — 0·5 D. vert. $= \frac{6}{9}$.

The vitreous continues clear in each eye, but whereas formerly I could detect no choroidal changes in the periphery, there are now many rounded spots of choroidal atrophy in the lower part of each fundus, especially the left, some of these bordered with pigment, others clean-cut and showing only the pure white scleral background. The fields for counting fingers and hand-movements show no gross impairment.

The President (Mr. J. H. Fisher) said that, considering the rarity of such cases, the Society was to be congratulated on having been the means of bringing before the profession at least two examples, both most fully and admirably reported. The great difficulty appeared to be to decide what form of toxæmia was at work. Through Dr. Ramsay's kindness he had had the opportunity of seeing the patient whose case he had described. At that time the eye condition was at its height. The vision was extremely poor, and he was much struck by the optimistic

view which Dr. Ramsay was still able to maintain about the case, although it was causing him and the relatives so much anxiety. That optimism had been fully justified by events. In these cases there seemed to be a definite tendency to ultimate recovery, showing that the patient was able to deal with the toxæmia. The coincidence of the recovery of vision in this instance was very striking in association with the administration of thyroid extract, but there were certain other symptoms which proved themselves to be evanescent and disappearing before any thyroid extract was given, and the body seemed to develop a potential resistance to these infections. It would be of interest if the exact sequence of symptoms in these cases could be collated. There appeared to be concerned the question of gastro-intestinal disorder, that of sensory nerve disturbance, with cutaneous manifestations, motor paralyses, and glandular involvement, classifying the ciliary and the parotid glands together. In this case there seemed to have been a synchronous onset of trouble in the eyes and in the parotid glands. He, the speaker, had wondered whether there was any special sex-incidence in these cases, *i. e.* whether they were predominant in females. But at present the number of records of such cases was very small.

Dr. C. O. Hawthorne regarded the case as particularly interesting because of the association of parotitis with cyclitis. Physicians were familiar with what appeared to be a non-specific parotitis in many different conditions, as, *e. g.*, some of the acute fevers, influenza, pneumonia, hæmatemesis, etc., and some years ago Mr. Stephen Paget drew attention to this development after abdominal operations. Though rival and competing explanations had been offered, one proposed that the parotitis was due to infection through the blood-stream, the other that it was the consequence of dryness of the mouth with infection through Stenson's duct. Dr. Maitland Ramsay's case hardly helps to settle this controversy, but it adds to the variety of local inflammatory disturbances with

associated fever in which parotitis may appear as a complication. It has sometimes been alleged that parotitis appearing in such various conditions as have just been mentioned is due to infection directly or indirectly from a person suffering from mumps. Such a story is difficult to believe and Dr. Ramsay's case affords no help to this suggestion. Dr. Hawthorne had long been interested in parotitis as a complication of various diseases, and therefore had listened to the present report with much pleasure. He believed that parallel cases were on record under the name "uveal fever."

Mr. J. Gray Clegg said the effect of the thyroid extract in this case was interesting because it was well known that thyroid had an influence on the function of the ciliary body; he had used it in that connection. With regard to cupping of the disc in this case without rise of tension, he had in mind one or two cases in which there had been cupping of the disc, and the glaucomatous signs and symptoms accompanying that, but where the ocular pressure was not above normal. In such cases he thought the operation of trephining would be a wise one. He had found that trephining in cyclitis where there was a tendency to a rise of tension and a beginning of contraction of the fields could be accomplished without upsetting the eye to any great extent; much less reaction occurred than when iridectomy was done. In this case he thought cupping of the disc was produced, not because the tension was high, but because the coats were particularly softened by the disease. The only point he wanted to make with regard to trephining was to make a large hole, and get out the whole disc when the tension arose from iridocyclitis.

Mr. Percival wished to make a remark about thyroid extract. His colleague, Mr. H. P. Bennett, had an amazing result after giving thyroid extract in a case of retinitis proliferans with recurrent haemorrhages, after the eye had seemed to be in a hopeless condition with P.L. only. He saw the case several times, but none of his

suggested treatments did good. Mr. Bennett then gave the patient a grain of thyroid extract three times a day, and in a week the condition had improved from not being able to see an electric light a foot off to being able to see an ordinary light dimly. Last time he heard of that patient she had $\frac{6}{9}$ in each eye. The case was recorded in a late number of *The Ophthalmoscope*. He believed that in Mr. Maitland Ramsay's case there was no hæmorrhage, but similar cases had been seen in which purpura occurred.

Dr. Maitland Ramsay, in reply, said he did not see the case until March 1st, and by that date the parotitis had disappeared. He knew of the cases to which Dr. Hawthorne had referred, and he made particular inquiry about diphtheria and mumps, but he was told there was no possibility that the patient had suffered from either of those diseases. Special attention was directed to the secretion from the throat and nose, with the view of finding some definite evidence as to the cause, but the result was negative. With regard to what Mr. Gray Clegg said about trephining no one knew of the cupping of the right optic disc until the vitreous humour had cleared up, when it was discovered by means of the ophthalmoscope. He did not regret that he had not operated. With regard to Mr. Percival's remark concerning hæmorrhages, he had read Sir William Osler's paper on eye conditions associated with erythema nodosum, etc.; he therefore examined the eyes very carefully, and he believed he was right in saying there had been no hæmorrhage.

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2. *Two cases of flat neoplasm of the choroid.*

By D. J. Wood.

(With Plate II.)

These cases are so uncommon compared with ordinary intra-ocular tumours that it seems desirable to report fresh examples.

Case 1.—In December, 1919, a young man, æt. 27 years, came to me complaining that he had lost the sight of his left eye about six weeks previously. There was a widely dilated pupil, a good deal of rather unusual redness on the outer part of the sclerotic, and a detachment of the retina close up to the back of the lens. Tension was normal, there was no pain, but I did not like the redness, and suspected a tumour. A Wassermann test was negative, but I learned that the patient was under a colleague for nose trouble, and was informed by him that there was disease in the left antrum and in the back part of the left lower jaw. We also found that there were enlarged glands on the right side of the neck. A portion of one was excised and the pathologist reported that it seemed to be epitheliomatous. The chances seemed therefore pretty hopeless, but I was once more made doubtful by the unexpected improvement in the glands under X-ray treatment. After a few weeks, however, I could see that there was an intra-ocular tumour as the iris began to bulge forward on the outer side, and I decided to excise the eye. An antero-posterior section revealed a typical flat growth, extending from the optic nerve forward to the iris, with a complete detachment of retina. A photograph gives a fairly good idea of the appearance (Fig. 34). Unfortunately the microtomist cut off in both this and the next case all the front of the eye, leaving only the tumour.

The growth is white with fine pigment markings, and firm in consistence. It is everywhere in contact with the sclerotic and infiltrates it. It goes right up to the optic nerve, but seems not to involve it.

Sections show an alveolar structure (Pl. II, fig. 1), but the cells seem to me to be epithelial and not sarcomatous, and the appearance would seem consistent with the opinion of Mr. Parsons that such growths are endotheliomatous. I obtained a section from the gland in the neck and found the same type of tumour and cell.

The patient did not return to me after the operation,

and died after about three months. There were fresh metastases, but no local recurrence. The metastatic

FIG. 34.

Case 1.

FIG. 35.

Case 2.

growths occurred without any ocular perforation. The retina was completely detached, and the subretinal fluid quite clear, not coagulating in the formalin fixative.

Case 2.—About the end of 1920 I was asked by a colleague to see a Jew of about 40 who had a glaucomatous condition of his left eye. He had only found the eye defective when it began to be painful. The eye was blind, the cornea steamy, the pupil dilated, and there was an area of redness on the outer part of his sclerotic which brought to my mind the case I have referred to. With a good light I was able to see on the inner side a detachment of retina and I had no doubt therefore that there was a tumour present.

He was admitted under me at the hospital and the eye was excised. Unfortunately neither the detached retina nor the area of redness were clues to the site of the growth. I made a horizontal section and found that I had missed the tumour, which occupied nearly the whole of the lower half of the fundus and was, as in the last case, a flat growth with a complete retinal detachment. The sub-retinal fluid was clear and did not coagulate in the formalin.

The growth began close up to the optic nerve and extended forward to about the ora serrata (Fig. 35). The surface was fairly like the rest of the choroid. It was white in section and firm, and about 5 mm. thick in the centre. It seemed to be in contact everywhere with the sclerotic.

To my surprise the section showed a totally dissimilar condition from my former case, the growth being composed of spindle cells (Pl. II, fig. 2), and was in fact a typical spindle-celled sarcoma. There was an area in front where a degeneration change had occurred, and I am unable to say whether this is myxomatous or hyaline, but I think the former. There was an absence of pigment, except in the outer layers, and the sclerotic seemed uninvolved.

So far there are no recurrences nor metastases which would agree with the less malignant character of spindle-celled sarcomata. It would seem, looking at these two cases, that the flat condition of growth may be assumed by tumours of very different histological structure.

The blocks with the rest of the tumour mounted on

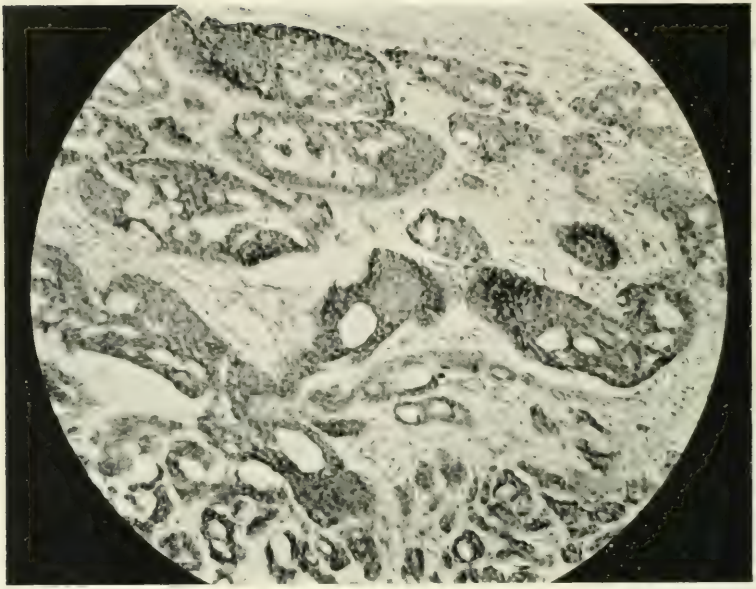

Fig. 1.

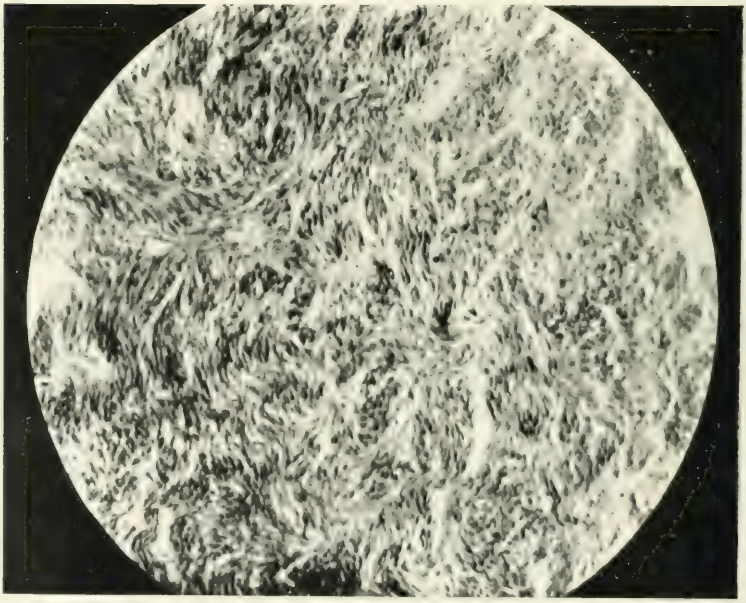

Fig. 2.

Adlard & Son & W. West Newman, Lith.

PLATE II.

Illustrates Mr. D. J. Wood's paper on Two Cases of Flat Neoplasm of the Choroid (p. 213).

Fig. 1.—Shows the microscopical appearances of the carcinomatous growth in Case 1.

Fig. 2.—Shows the microscopical appearances of the sarcomatous growth in Case 2.

them have been sent to Mr. Treacher Collins in order that he may be able to express an opinion on the cases.

Pathological Note by E. Treacher Collins.

I have examined sections of the two interesting specimens of flat new growth of the choroid which Mr. D. J. Wood kindly sent me. In the specimen of the first case the cells of the growth, as Mr. Wood says, are of an epithelial type and arranged in an alveolar fashion. The appearances of the sections and the history of the case suggest to me that the growth is probably a secondary carcinoma of the choroid. There was, besides the eye affection, disease of the nose and enlargement of the glands in the neck. A section made from one of the latter, after its removal, was said to show an epitheliomatous growth. Metastatic carcinoma is known to invade the lymphatic spaces of the choroid, and grow in a diffuse way, so as to give rise to a flattened thickening rather than a localised knob-like protrusion.

It is still a debatable point as to how a secondary carcinomatous growth reaches the eyeball—whether by the blood-stream, or by permeation along the lymphatics, as is so frequently the case in other tissues which become secondarily involved. In the sections of this specimen the lymphatic sheaths of the posterior ciliary arteries and nerves, external to the eyeball, are found to be extensively infiltrated with the cells of the growth. One of the short posterior ciliary arteries where it perforates the sclerotic is seen to have cells of the growth thickly clustered around it in its passage, and extending into spaces between the fibres of the sclerotic from its vicinity. Such appearances are what we should expect to find if the growth had reached the eyeball by permeation along the lymphatic channels. It is possible, however, that a metastatic growth having started in the choroid is extending out of the eyeball along these channels.

Sections from the specimen of the second case show a

growth composed mainly of a mass of spindle-shaped cells, traversed by numerous thin-walled blood-vessels. The cells encircle the vessels, and in many places can be seen springing from their outer surface, and radiating forth from them. The anterior part of the tumour, that described by Mr. Wood as a degenerating area, presents different structural characteristics to the rest. There is a more conspicuous inter-cellular fibrous stroma; the nuclei of the cells in the stroma have stained deeply, but in places the cell protoplasm has undergone degeneration and some vacuolation. In other parts the cells are still well formed, and instead of being spindle-shaped, as in other parts of the tumour, are of an endotheliomatous type.

The sections of this specimen show, therefore, two different types of neoplastic formation, the main mass presenting the appearance of a spindle-celled angio-sarcoma, and the anterior smaller section that of an inter-fascicular endothelioma. As Parsons has pointed out, the flat sarcomata which have been described have mostly been tumours of the latter type. Tumours of the former type grow generally in a localised rather than a diffuse fashion.

The variations in the mode of growth of the different forms of sarcoma of the choroid have been attributed to the different sites in the choroid in which the tumours originate. Interfasicular endotheliomata starting in the lymph spaces on the external surface of the choroid spread in them, between the choroid and the sclerotic. Angio-sarcomata starting in the inner vascular layers press inwards the elastic membrane of Bruch until it ruptures, and then extend inwards through the gap so formed.

This specimen of Wood's, comprising two forms of growth, has not produced sufficient pressure on Bruch's membrane to rupture it, but has formed a rather thicker layer of new growth than that which is usually met with in the diffuse sarcomata.

VII. DISEASES OF THE LENS.

1. *The influence of age on the power of the crystalline lens.*

By G. F. Alexander.

Regarding the refraction of the crystalline lens, quoting (*a*) from p. 5, *The Prescribing of Spectacles*, by A. S. Percival, "the lens consists of a dense nucleus surrounded by concentric layers of a less dense material: these peripheral layers may be considered as forming two diverging menisci which enclose the nucleus and diminish its refractive power: when the cortical layers of the lens become more dense with age the refractive power of these menisci becomes greater and therefore the power of the whole lens becomes less"; and (*b*) from p. 30, *Physiological Optics by Tscherning*, "on account of its great curvature and high index the nucleus has a refractive power which is diminished by the influence of the cortical layers, which act as two concave lenses; if the index of these layers were higher their influence would be greater and the refractive power of the whole crystalline lens would consequently be weaker"; it is evident that as these statements, which appear to be universally accepted, are by the above and all other writers supported by a diagram representing the cortex acting as a concave meniscus, they are tantamount to the assertion of the presence in the lens of surfaces acting as concave refracting surfaces, and that the increase in the index of the cortex is by increasing their power the cause of the diminution of the power of the lens as age advances.

In criticism of the above, I contend first that there are no such surfaces in the lens. In regard to refraction a

spherical surface separating two media of different indices is convex if its centre is on the side of the one of greater index, and concave if it is on the side of the one of less index, and as in the lens and its nucleus the more central the lamellæ are the higher are their indices, the centre of their curvature must in every case lie on the side of the medium of greater index, hence the surface separating the cortex and nucleus is a convex and not a concave one, and a ray incident on either surface of the lens encounters in its transit through it a series of convex refracting surfaces, and at no part of its course a concave one.

Second, that the cause of the diminution of the power of the lens as age advances is the diminution in the convexity of its surfaces and those of the nucleus from their growth.

Though increase in the index of the cortex diminishes the power of the surfaces of the nucleus it increases the power of the surfaces of the lens, and as it is accompanied by increase in the index of the nucleus which increases the power of the surfaces of the nucleus, it is not necessarily associated with diminution of the power of the lens as a whole, and that the reverse is the case will now be shown.

If r is the radius of a surface separating a medium of a lower index μ_1 from one of a higher index μ_2 and its centre is in the latter, as the first and second focal lengths are—

$$\frac{\mu_1 r}{\mu_2 - \mu_1} = \frac{r}{\frac{\mu_2}{\mu_1} - 1}, \text{ and } \frac{\mu_2 r}{\mu_2 - \mu_1} = \frac{r}{1 - \frac{\mu_1}{\mu_2}}$$

respectively, it follows that (*a*) if r is increased the focal lengths are increased and therefore the power of the surface is diminished; (*b*) if μ_2 increases proportionately to μ_1 the focal lengths are unaltered and therefore the power of the surface remains the same; (*c*) if μ_2 increases out of proportion to μ_1 the focal lengths are diminished,

and therefore the power of the surface is increased, and (*d*) if μ_1 increases out of proportion to μ_2 the focal lengths are increased and therefore the power of the surface is diminished.

Applying the above first to the surfaces of the nucleus, as μ_1 becomes the index of the cortex and μ_2 that of the nucleus it follows that the power of the nucleus tends to diminish with its growth, and that though normally μ_2 increases out of proportion to μ_1, so that its power tends to increase, if the reverse takes place as is the case if μ_1 and μ_2 increase by equal increments its power tends to diminish.

Second to the surfaces of the lens, as μ_1 becomes the index of the aqueous and vitreous and μ_2 that of the cortex, it follows that the power of these surfaces tends to diminish with the growth of the lens, and as μ_1 remains constant any increase in μ_2 causes their power to increase. It remains to prove that if the index of the nucleus rises with that of the cortex, if only by equal increments, the increase in the power of the surfaces of the lens, caused by increase in the index of the cortex relatively to that of the aqueous and vitreous, more than counter-balances the diminution in the power of the nucleus caused by increase in the index of the cortex relatively to that of the nucleus, and therefore increases the power of the lens as a whole, which is done as follows: If r_1 and r_2 are the respective radii of the front surfaces of the lens and nucleus, T the distance between these surfaces, μ_1, μ_2 and μ_3 the respective indices of the aqueous, the cortex and the nucleus, and F is the posterior focal length of the equivalent of these surfaces,

$$F = \frac{\mu_2 \mu_3 r_1 r_2}{\mu_2 r_1 (\mu_3 - \mu_2) + \mu_2 r_2 (\mu_2 - \mu_1) - T (\mu_2 - \mu_1)(\mu_3 - \mu_2)},$$

and as the same applies to the posterior surfaces of the lens and nucleus, μ_1 then becoming the index of the vitreous and F the anterior focal length of the equivalent of these surfaces, by giving values in this expression it

becomes manifest that (*a*) μ_1, r_1 and r_2 remaining constant, if μ_2 and μ_3 are increased by equal increments F becomes less, *i. e.* the power of the four surfaces in combination and therefore that of the lens is increased; (*b*) μ_1, μ_2 and μ_3 remaining constant, if r_1 or r_2 or both are increased F becomes greater, *i. e.* the power of the four surfaces in combination and therefore that of the lens is diminished.

It follows from the above that (1) as the radius of the surface of the lens is greater than that of the surface of the nucleus, if in estimating the power of the lens we take the former we must, in order not to undervalue it, as Thomas Young pointed out, adopt a higher refractive index than that of the nucleus.

(2) The only factor tending to diminish the power of the lens as age advances is the increase in the radii of its surfaces and those of the nucleus accompanying their growth, but as this tendency is opposed by increase in the index of the cortex and more especially in that of the nucleus taking place as age advances, (*a*) no change in the refraction of the eye may take place; (*b*) if the growth of the lens and nucleus is in advance of the increase in the indices hypermetropia will be acquired, though this may also be due to failure in the tonic contraction of the ciliary muscle to increase the curvature of the surfaces of the lens from diminution in the amount of the cortex and in the ease with which it can be moulded; and (*c*) on the other hand, if the increase in the indices is in advance of the growth, as is occasionally the case with that of the nucleus from the hypersclerosis which often proves transitional to nuclear cataract, myopia will be acquired.

The PRESIDENT said the note was one which was well worthy of being brought forward, though the idea that a portion of the lens could act as a concave meniscus was not, to him, comprehensible. One had to view the lens as increasing in density from the periphery to the central portion, and it was difficult to speak theoretically of the

action of the nucleus and the cortex —two portions which could not be absolutely differentiated the one from the other. It was perfectly possible to carve a concave meniscus out of a biconvex lens; it would be equally possible to shape it out of any block of solid material.

Mr. PERCIVAL said he had been attentively listening to this paper, but he could not follow Mr. Alexander's argument. In youth the lens consisted of a dense nucleus surrounded by concentric layers of a less dense material. These peripheral layers may be considered as forming two divergent menisci which enclose the nucleus and diminish its refracting power. Let the nucleus be assumed to remain unchanged; if the refracting power of these *diverging* menisci becomes greater the power of the lens becomes less, and *vice versâ*. This surely cannot be denied, as it rests on elementary optical principles. (He illustrated his view by means of a blackboard sketch.)

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2. *A note on a method of extracting the crystalline lens in its capsule by means of "suction."*

By ARTHUR W. ORMOND.

IN operating for cataract it has usually been my custom to incise the anterior surface of the lens capsule with a sharp hook, by means of which I make a circular incision by a rotatory movement over the surface of the lens. Noticing the frequency with which the whole lens was moved while doing this, it occurred to me that it might be caused by the use of unnecessary force, but this proved not to be so, but to be due to the fact that in senile cataract the suspensory ligament is often a very feeble and degenerated structure and dislocation of the lens can be easily produced by direct pressure applied to its surface. From this I came to the conclusion that the lens might possibly be delivered in its capsule by means of *suction* instead of by *expression*, which is the method employed by

other operators who remove it in its capsule. The advantage of removing a lens in its capsule is obvious to any ophthalmic surgeon, and provided the benefit is not obtained by undue risk and the technique of the method is not difficult, it is one which I suppose would appeal to most.

I spoke of my idea to Messrs. Weiss, who took up the suggestion enthusiastically and made for me a very simple apparatus which I call a "cup extractor." This "cup extractor" is something like an enlarged Meibomian scoop having a hollow handle communicating with the cup, and the instrument is connected to the vacuum by means of "pressure" tubing made of india-rubber. This arrangement I have used and found satisfactory.

At this point it was necessary to consider the best means of obtaining suction-power. The methods are many, but that apparatus chosen should be simple in application, readily sterilised, and if possible inexpensive. The simplest would be similar to an ordinary enema syringe to which the "cup extractor" might be directly fixed. Direct suction would be obtained by squeezing the india-rubber ball and inserting the extractor over the lens. The reason why this is not practically a satisfactory method is because in the course of the operation, fluids, etc., used in washing the eye and site of the wound are usually present, and some of this would be drawn into the india-rubber ball, which would have to be sterilised a second time should the cup extractor have to be applied twice during the operation.

I personally have used two methods:

(1) An "exhausted receiver" method.

(2) A "filter pump" method.

The first consists of a toughened glass bottle capable of holding about a quart of fluid. In the neck of this bottle is fixed an india-rubber stopper perforated by two metal tubes with stop-cocks attached to each. One of the tubes is connected by means of india-rubber pressure-tubing to a small hand exhausting pump, the other by

similar means to the metal "cup extractor." The bottle is exhausted and the tap turned off so as to isolate the pump from the receiver. Now on turning the other tap, *i. e.* the one between the receiver and the cup extractor, the vacuum is connected with the latter. This method was introduced in principle many years ago, but apparently was not generally applied, or at any rate not in this country. In the *Ophthalmic Record* of 1910 will be found an account by Dr. Vard Hulen of an apparatus (which he also illustrated) consisting of a large bicycle pump to exhaust a 5-gallon carboy, which was attached to a "cup extractor" similar to the one made by Messrs. Weiss for me. The unwieldiness of the apparatus perhaps mitigated against its utility. The principle is good, and with modifications the apparatus has this advantage, that it can be made portable, and so could be easily carried about by an operator wishing to operate away from his usual theatre.

The other method of obtaining a negative pressure is by the "filter" pump made on the principle of the Bunsen Sprengel Pump, an application of a device frequently seen in physical laboratories.

The principle of this filter pump is that a rapid stream of water flowing in a given direction carries with it the surrounding air in its immediate neighbourhood. Fresh air rushes in to supply the place of that carried forward, so that there is a continual rarefaction of the air around the current and therefore an aspiratory action is produced.

If we take a stout glass tube having a side arm, and fit it by means of pressure tubing to an ordinary water-tap, the pressure of the flow of water through the tube is sufficient to carry with it a current of air, and the air must consequently be drawn in from the side arm. By this method the pressure may be reduced to 15 or even 10 mm.

The water filter pump is very simple, and could be fitted up in any operating theatre for a few shillings.

The University type of filter pump I have found the most efficient. This consists of a glass tube which can be fixed to an ordinary tap by pressure tubing. On one side of the tube is an arm set at right angles, to which a length of rubber pressure tubing is attached, and with the other end of this the "cup extractor" is connected. Inside the glass tube is an ingenious device for increasing the rapidity of the flow and so diminishing the time taken to obtain a negative pressure, as well as increasing the amount of that negative pressure. This consists of a long thin funnel, the narrow end of which is fixed over an inverted funnel, the opening of the lower funnel being slightly the larger, and surrounding (without touching) the spout of the upper one. Water rushing down is conducted in a thin rapid stream across the opening between the two funnels; in its passage it sucks in the air in its neighbourhood, and as the only source from which air can be drawn is the tube with the side arm, it is obtained thence. To this side arm the pressure tubing and the cup extractor as already mentioned are attached. When the air has been entirely removed from the tubing the cup extractor fixed at its end then becomes part of the vacuum; a tap inserted in the handle of the instrument gives the operator control over the pressure.

Operation.—The patient is prepared in the ordinary way, and no special precautions are necessary.

The incision is made most advantageously at the periphery of the anterior chamber, and the knife should not be brought out through the cornea. It should be a large incision, as the diameter of the cup is at least 5 mm., that of the lens in its capsule 9·1 mm.; the average diameter of the cornea is given as about 12 mm. in the horizontal, so that the incision should be rather more than a third of the whole circumference of the cornea, and the more peripheral it is the better. No doubt an iridectomy does facilitate the extraction, but it is not an absolute necessity. In inserting the "cup extractor," it is most important to see that the edge of the instrument is everywhere under

the iris and does not nip it between the instrument and the lens. Haemorrhage occurring during the incision or blood escaping from the cut conjunctiva into the anterior chamber complicates the operation by preventing an uninterrupted view of the instrument. Having inserted the scoop, and having seen that the iris is not involved, the "cup extractor" is connected with the vacuum by turning the tap. At once the lens is felt to be gripped, and by a to-and-fro movement may be shaken free of its attachment to the suspensory ligament and withdrawn from the eye attached to the "cup extractor." It is not necessary in all cases actually to remove the lens from the eye by the instrument. When the lens has been freed from the suspensory ligament it may be released and the instrument removed, leaving the lens *in situ* but detached; it may then be expressed in the usual way. This prevents the necessity of having an abnormally large incision, as the cubic capacity of the lens attached to the cup is larger than either the "cup extractor" or the lens alone. The main object of the operation, viz. the removal of the lens in its capsule, would still be obtained.

The maximum pressure which can be obtained by this method of suction is, of course, one complete atmosphere—that is, roughly 15 lb. to the square inch. Practically, of course, the actual suction power obtained depends upon the efficiency of the apparatus used—its condition of "air tightness," the water-pressure used, the temperature of the room, the reading of the barometer, and the absence of moisture in the air, all of which make slight differences to the actual result.

I have obtained by means of the water-filter a pressure equal to 750 mm. of mercury—that is, only 10 mm. short of a theoretical maximum; but a lower pressure—anything equal to 700 mm.—is usually sufficient, and this allows a wide margin for defects in the apparatus used. Where the vitreous is healthy and affords a sufficiently firm fulcrum for lever action, a certain increased power is obtained by passing the "cup extractor" to the

lower part of the lens and using the cup partly as a scoop.

On occasions I have removed some vitreous, but only when it was "watery," but these cases did quite well. There is danger in using too great a force, but of course, on the other hand, it is useless to use a force insufficient to rupture the suspensory ligament; obviously it will vary in different cases, but I have found a pressure *approximating* to one atmosphere sufficient.

There is one great point I should like to emphasise, and that is this: If for reasons such as hæmorrhage, or too small a corneal incision, or too resistant a suspensory ligament, the operation cannot be completed by this method, at no stage of the proceedings is the surgeon prevented from completing the operation by the ordinary method of incising the capsule.

Twice it has happened to me, once owing to hæmorrhage, and once owing to having made too small a corneal incision, that I was unable to complete the operation of removing the lens in its capsule, but I did not fail to obtain a perfectly satisfactory result as far as the patient was concerned, by reverting to my usual method of incising the capsule. This is a very important point, as one might hesitate to employ any new technique, for fear of not succeeding in carrying the new method to a successful finish.

I have not so far made any reference to the work so successfully carried out by Dr. D. E. Barraquer, of Barcelona, and communicated by him to the Royal Academies of Medicine and Surgery of Madrid and Barcelona in July, 1917.

A *résumé* of this has been published in the *British Journal of Ophthalmology* recently, and I have also, since working at this subject myself, received a pamphlet, describing the "vibratory vacuum" employed by him. It is very difficult to understand from the description, published in English, what exactly is the amount of pressure Dr. Barraquer uses; as far as I know it is not yet stated. He obtains a

"vibratory vacuum" by means of a pump working in oil and set in motion by electricity.

I am somewhat prejudiced in my mind by the apparent expense and elaboration of the instrument advocated by him, and if, as I believe, sufficient suction-power can be obtained by simpler means, then surely that is an advantage.

The PRESIDENT said Dr. Maitland Ramsay was able to bring Barraquer's instrument to St. Thomas's Hospital, and he maintained that the vibratory vacuum was the central point. It was a fine point as to when the zonular fibres were ruptured. He (the speaker) had the impression that the vibratory vacuum was much less than that obtained by the Sprengel pump, and he would have thought a pressure of anything like 15 lb. to the square inch was liable to produce over-suction. The difficulty Dr. Ramsay encountered with a suction apparatus before he had received Barraquer's instrument was that the capsule was ruptured by the suction, and therefore he did not complete the operation as an intracapsular extraction.

Mr. A. W. ORMOND (in reply) said he had used the instrument on rabbits' eyes; he did not dilate the pupil before making the incision. Dr. Barraquer would probably obtain a little better pressure if he were to use a very rapid rotatory pump.

3. *Case of discoid cataract.*

By N. BISHOP HARMAN.

A WELL-GROWN, healthy-looking girl, æt. 14 years, was referred for the examination of her eyes. She has had some difficulty in reading in the evening. There is nothing about the general appearance of her eyes which suggests

the nature of the defect found; she is open-eyed, without any tendency to lid closing, and there is no frown.

She is the sole child of her parents; there have been no other pregnancies. There is no history of maternal illness during pregnancy. The mother is a healthy woman, her eyes are normal. The father has been seen, and has normal eyes.

The girl's eyes are healthy except for the peculiarity in the lenses. There is a small error of refraction. R.V. with + 1·5 D. sph. and + 0·5 D. cyl. ax. vert. = $\frac{6}{18}$. L.V. with similar correction = $\frac{6}{12}$.

In the deepest layers of each crystalline lens there is a small, sharply-defined, very thin disc of opacity. It has just those characters which have been made familiar to us by the descriptions of the late Mr. Doyne, and which have been variously called Doyne's cataract, Coppock cataract, or discoid cataract. The second name is derived from the family, whose lengthy pedigree was worked out to so large an extent by Mr. Nettleship. This girl has no connection with the Coppock family; her forbears have been Londoners for several generations past, and have no connection that is known with Oxfordshire. Incidentally it may be of interest to note that I have recently seen three descendants of the Oxford Coppock family, but these have not shown any sign of the family cataract, only errors of refraction.

4. *Partial monocular lamellar cataract associated with persistent pupillary membrane and birth injury.*

By John Gray Clegg and Gordon Renwick.

(With Plate III, fig. 1, p. 235.)

Fred I—, aet. 8 years, brought to the Manchester Royal Eye Hospital for defective vision of left eye. Mother stated that instruments had been used at birth,

and that a swelling had remained over left eye for some ten days. The left eye always seemed "queer." The boy is well built, and nothing abnormal is found other than the eye condition. Teeth have normal enamel, but are irregularly placed. There are no signs of rickets, no history of fits or convulsions in infancy. Two marks are seen over the left brow as if from the edge of the forceps. Mother, father and two sisters perfectly healthy. Right lens and media clear, F.N.

R.V. $= \bar{c} + 3$ D. sph. $\bar{c} + 1$ D. cyl. vert. $= \frac{6}{6}$. J.1.

L.V. $= \bar{c} + 3$ sph. $\bar{c} + 1$ D. cyl. down and out (skiascopy) = fingers.

Left, with oblique illumination, shows two fine bluish-white threads of persistent pupillary membrane which are seen running from the centre of the lens to the circulus minor. One bifurcates before reaching its iridic attachment. These lie over the lental opacity to be described. The pupil is perfectly round, and dilates quite well with mydriatics. Towards the outer part of the lens is seen a partial lamellar cataract, occupying, roughly, one quadrant. The anterior and posterior layers meet towards the outer edge at a sharply-curved margin, well within the periphery. The opacity is not very dense, but is perfectly distinct. It resembles in shape and appearance a partially-opened bivalve shell. Clear lens substance lies between the valves. The posterior layer has a slightly brownish tinge. The inner margins are frayed. A minute brown dot lies on, or in, the anterior capsule slightly inwards from the centre. The vitreous and fundus are quite normal. The fields are full, and there is no scotoma in the left eye (see Pl. III, fig. 1, p. 235).

With regard to the causation of lamellar cataract in general, they commended members to the exhaustive paper by Mr. Treacher Collins given at the Liverpool meeting of the North of England Ophthalmological Society and published in the last volume of the *Transactions*. The frequency of its occurrence can be gathered from twenty years' figures at the Manchester Royal Eye Hospital,

where out of 656,126 out-patients, 686 cases of this type of lental opacity were found, that is, practically, 0·1 per cent. In his own private practice Mr. Clegg estimated that out of some 19,000 persons 51 cases were seen, giving a percentage of 0·27. The occurrence in one eye only is rare, and still more so a partial opacity, especially if monocular. The present case was peculiar, in that it was associated with a persistent pupillary membrane and a distinct history of injury. They would refer to two cases reported in the *Transactions* of this Society of partial lamellar cataract in one eye, the first by Mayou, in 1905 (vol. xxv, p. 88, Pl. X), and the second by Treacher Collins in 1916 (vol. xxxvi, p. 403, Pl. I). In fact, Mr. Collins' case was practically identical with the one now recorded. The points he made then were: (1) The incomplete character of the zone of opacity in a cataract which appeared to be of zonular type; (2) the appearance of a zonular cataract in only one eye; (3) the history of the injury to the affected eye at birth; (4) the presence of remains of the pupillary membrane. Mr. Collins concluded that it was possible that the pressure to which the globe was subjected might have caused some disturbance in the lens affecting what were then its most peripheral layers, and this more in one portion of its circumference than elsewhere. It might also have excited some adhesive inflammation in the pupillary membrane, causing it to become adherent to the lens capsule and persist. The deposition of new lens-fibres outside what was the peripheral zone at first would account for the clear unaffected cortex.

These remarks of Mr. Collins were entirely *à propos* of the present case.

Mr. E. Treacher Collins said it was very desirable to have more cases of unilocular lamellar cataract put on record. In the paper which he read before the North of England Ophthalmological Society last year he put forward a plea for more records of such cases, and he

was glad to see a response in this paper by Mr. Gray Clegg and Dr. Renwick. In most of the cases of unilocular lamellar cataract of which he could find records there was a history, or a probable history, of traumatism. His own view was that traumatism accounted for these cases. The coincidence of a persistent pupillary membrane might seem difficult to explain in connection with traumatism, but in a surprisingly large proportion of infants' eyes remnants of a pupillary membrane were found at birth, and an injury at that time might give rise to an inflammatory adhesion, which would cause it to persist.

Mr. M. S. Mayou said he had not recently looked up the notes of his similar case, but he did not think there was any history of birth-injury in it.

Mr. Inman thought it strange that the condition was not more common, if due to injury, considering the frequency in later years of injuries comparable to those received at birth.

Sir William Lister showed a drawing of a partial cataract of the zonular type, following an injury which occurred in adult life, which would give the answer to Mr. Inman's remark. Mr. Marcus Gunn had a case years ago at Moorfields, in which there was a definite zonular cataract that occurred late in life.

The President [Mr. J. Herbert Fisher] said that what came out of the discussion was the persistence of the pupillary membrane, which had to be explained, and, presumably, on the same cause as the development of the unilateral lamellar shell. What had struck him was the large size of the lamellar shell, which would agree with the size of the lens at birth, and to that extent be suggestive of a birth-injury.

Mr. C. Goulden said he had seen one case, possibly two, similar to this described by Mr. Gray Clegg. In connection with one of them, seen in France, Sir William Lister pointed out to him the origin of them. That soldier had partial lamellar cataract in one eye ; the injury had been inflicted when he was fifteen years of age. He was

interested in the case because he had not heard, till then, that partial lamellar cataract might follow injury. There was a small opacity in the periphery of his lens. He did not know what the nature of the injury was.

Mr. Gray Clegg (in reply) said he showed the case at the North of England Ophthalmological Society. He had seen a case of exactly half a zonular cataract in one eye. The interest of the case, he thought, lay in the light it threw on the formation of lamellar cataract in general. As to the opaque portion not extending to the periphery, Mr. Collins had pointed out that when, owing to temporary disturbance of nutrition an opaque layer had been laid down in the lens, clear fibres were formed outside and the inner nucleus tended to contract, so that the older the patient became, to a certain extent, the smaller would be the zonule. If he remembered rightly from Mr. Collins's paper the size of lamella now described would correspond with the laying-down of opaque fibres at the time of birth. Actual measurements were given in Mr. Collins's paper.

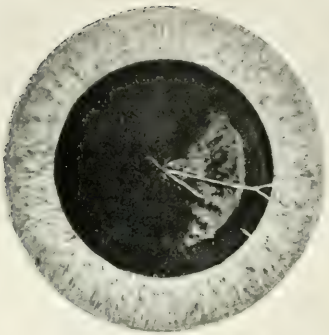


Fig. 1.

Fig. 2.

Adlard & Son & West Newman, Ltd.

PLATE III.

FIG. 1.—Illustrates Mr. John Gray Clegg's and Mr. Gordon Renwick's paper on Partial Monocular Lamellar Cataract associated with Persistent Pupillary Membrane and Birth Injury (p. 230).

FIG. 2.—Illustrates Mr. J. Herbert Fisher's paper on Connective Tissue on the Central Part of the Retina in a Patient who has suffered from Malaria, the Organisation having taken place in all probability in a Film of Blood Extravasated from an Obstructed Retinal Vein (p. 235).

VIII. DISEASES OF THE RETINA.

1. *Connective tissue on the central part of the retina in a patient who has suffered from malaria, the organisation having taken place in all probability in a film of blood extravasated from an obstructed retinal vein.*

By the President (J. Herbert Fisher).

(With Plate III, fig. 2.)

P. McG—, æt. 24 years, male. Complained on January 17th, 1921, that he had noticed a dimness of the vision of the right eye, especially in the last eight or nine days, though he had observed some disturbance of his vision when walking in the country some six months earlier. He had suffered from malaria in India in 1917 and again twelve months ago, and since returning to England had had ague attacks from time to time. Had been liable to constipation, which had been benefited by the administration of Kruschen salts.

The urine was normal and the Wassermann reaction negative.

The left eye is quite sound and has full vision.

The vision of right eye was $\frac{6}{24}$ partly.

The ophthalmoscopic appearances are those depicted in the drawing (Pl. III, fig. 2). An ill-defined area of glistening grey tissue is seen over the macular region, apparently on the surface of the retina, and by dragging upon the retina has thrown it into radiate folds in the direction of the temporal margin of the O.D. No blood extravasations seen.

On April 11th, 1921, the appearances are unchanged.

The retinal vessels, especially those below the affected area, are tortuous, and have certainly undergone disturbance or anastomotic development; the appearance of the inferior temporal vein suggests that there is some obstruction of its lumen at a point where it is crossed, about 1½ p.d. from the O.D., by the corresponding artery, while into the vein drains a zigzag tributary beyond the point where the interference is deemed to exist.

2. *A case of malignant malaria.*

By Prof. Leonard S. Dudgeon.

(With Plate IV.)

European War, 1914–19.

History.—Pte. — died in the Doiran-Vardar sector of the Balkan front from malignant malaria.

He had suffered from previous attacks of malaria.

Present illness.—This commenced while on sentry duty. He began to feel drowsy and had severe headache. Was admitted to a field ambulance. Headache increased and also drowsiness. These symptoms were followed by failure of vision, which rapidly increased. Quinine was not administered in excess. Patient was dead in thirty-six hours from the onset of the acute illness and was completely comatose before death.

A very complete post-mortem examination was made by Capt. Cecil Clarke, and samples of all tissues were sent to me for investigation.

The brain showed very advanced changes, such as occur in comatose cases of malignant malaria. They were so advanced, however, that a painting was made by Cpl. Panichelli, M.S.M., from which the black and white drawing is taken (Fig. 36).

The brain was greyish-brown in colour, dry, and the white matter throughout showed thrombosis of vessels,

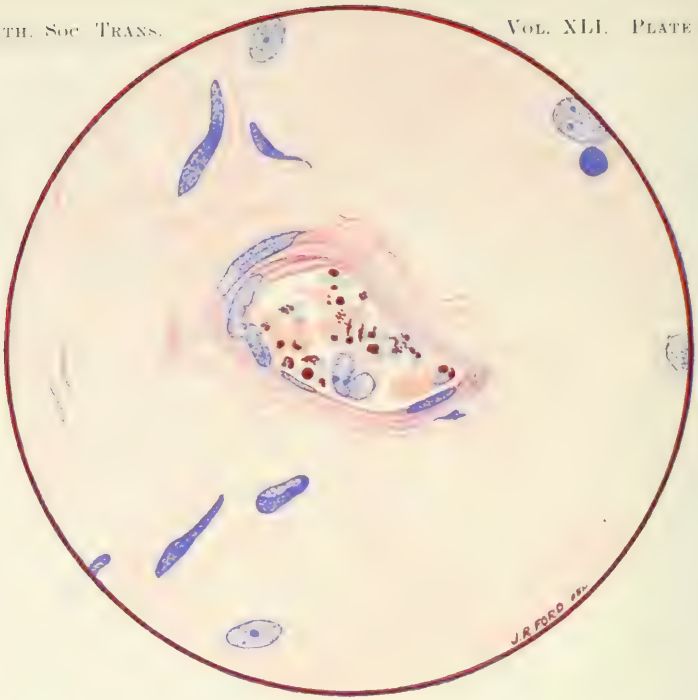


Fig. 1.

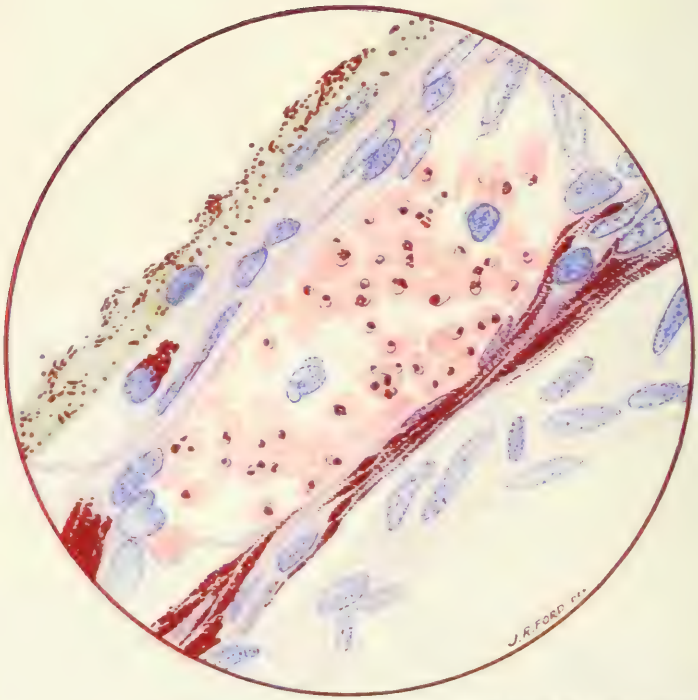


Fig. 2. *Adlard & Son & West Newman, Lith.*

PLATE IV.

Illustrates Prof. Leonard S. Dudgeon's paper on A Case of Malignant Malaria (p. 236).

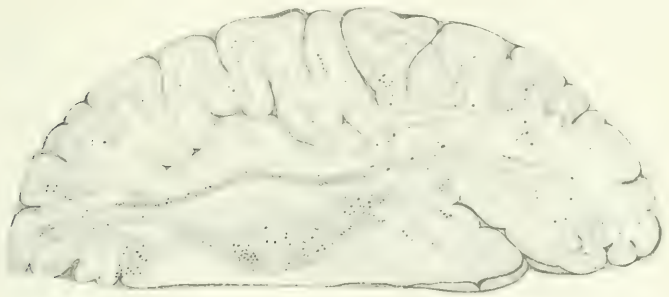
Fig. 1.—Shows a microscopical section of the optic nerve with intravascular parasites.

Fig. 2.—Shows a section of the retina with a vessel containing infected red cells.

congested vessels and haemorrhages. The thrombosed vessels stand out in the diagram as coarse black points. The thrombi consist of infected red cells, masses of dot parasites, particles of melanin and mononuclear cells. These thrombi could not be removed from the vessel-walls without injury to the tissues. There is no perivascular exudation of the vessel walls.

Pl. IV, fig. 1 : Section of optic nerve showing a blood-vessel which contains infected red cells and masses of parasites with coarse melanin particles. No perivascular exudation present.

Fig. 36.



Pl. IV, fig. 2: Section of retina. This diagram shows a retinal vessel filled with red cells heavily infected with malarial parasites. Note that some of the red cells contain many parasites. Each parasite contains coarse melanin granules. All the vessels of the retina, iris and optic nerve were in a similar condition.

The President referred to his case of organised pre-retinal exudate following malaria, and said the case was of some interest when associated with the microscopic sections prepared by Prof. Dudgeon, showing blockage of retinal vessels with malarial parasites. Those sections had been obtained from a patient on the Balkan front who had been in a condition of coma, the reason for that being sufficiently revealed by the drawing of the cerebral

hemisphere shown with the sections, which showed that there was a blockage in many of the vessels of the cerebrum, with innumerable punctiform hæmorrhages scattered through the brain-matter. He considered those microscopic sections of malarial parasites in the retina absolutely unique, and had taken the liberty of asking Prof. Dudgeon to get some of the sections reproduced in colour for publication in the Society's *Transactions*, together with a short note, and he believed they would be the first sections of that character to be published in any ophthalmological society's transactions.

3. *A case of retinitis of obscure origin.*

By A. C. Hudson.

Walter G—, æt. 38 years, fitter.

November 18th, 1920: R.V. blurred four days. Typhoid, scarlet fever and measles before the age of 10; no illness since. Smokes about one ounce of tobacco a week; has never chewed tobacco. No abnormality in diet detected. Throat healthy; teeth fairly good. Urine normal. Wassermann reaction negative. R.V. $= \frac{6}{9}$: faint œdema of retina up and in from macula. L.V. $= \frac{6}{6}$: fundus normal.

December 6th: R.V. $= {}_{1}\frac{6}{2}$. Small white spots in œdematous area of retina. Small central scotoma for colours.

December 30th: R.V. $= {}_{2}\frac{6}{4}$. Appearance of opacification, with white spots in retina more pronounced.

April 7th, 1921: R.V. $= \frac{6}{6}$ partly. Opaque area at macula with bright spots in it, bounded below by a semicircular relatively depigmented zone, with some excess of pigment below it.

(Sketches of three similar fundi shown.)

IX. INTRA-OCULAR TENSION.

1. *A justification of the wide iris-prolapse operation for glaucoma.*

By H. Herbert.

This operation has been already considered in the *Trans. Ophth. Soc. U.K.*, 1919, p. 220, and in the *British Journal of Ophthalmology*, 1920, p. 216. I have performed it upon forty-one eyes in this country during the last two years, modifying and fixing the technique somewhat.

The aim is merely to reproduce with certainty a condition (Fig. A) which has at times formed a very unwelcome complication of simple cataract extractions and of sclerotomies—the subconjunctival protrusion of a wide and more or less bulging fold of iris, which may be expected gradually to undergo a superficial fibrous change, and slowly also to lose its prominence.

The indiscriminate rejection of all iris-inclusion operations for glaucoma seems to me nowadays indefensible, arguing a want of acquaintance with results easily obtainable, and a lack of appreciation of the need for such results.

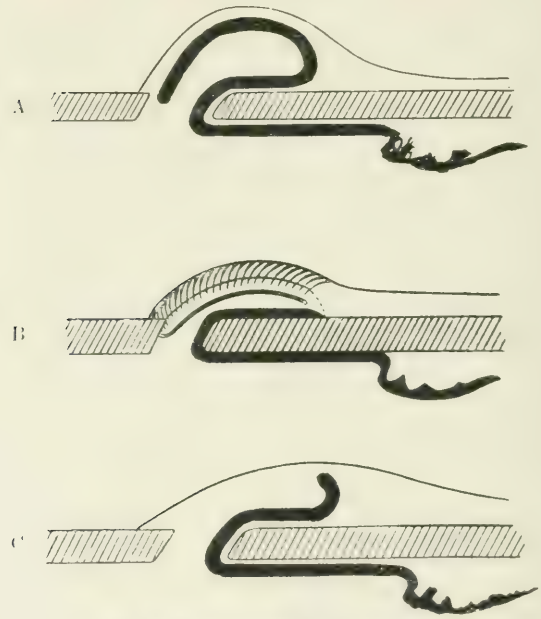
So far as I can judge, this particular iris-prolapse method may well prove to be the soundest available treatment for many advanced glaucomas. In some of the higher-grade cases this method seems perhaps to be the only way of providing the required free drainage safely; and in some low-grade glaucomas, particularly where the fellow eye is blind or nearly so, the treatment has claims to consideration, because the relief of tension thus obtainable seems much more certainly permanent than by other means.

The main object of the present paper is to justify the above opinion. But it is necessary first to give in a few

words the *technique* now used. It will be described in detail elsewhere.

Latterly I have used a broad keratome incision close to the upper corneal margin, with conjunctival opening at least 5 mm. away. Means have to be taken to avoid accidental conjunctival puncture near the limbus. I have generally injected normal saline solution before sliding the

FIG. 37.



A. Early prolapse. B. Late result.
C. Prolapse with widely dilated pupil.

conjunctiva. The conjunctival opening is afterwards sutured, to avoid a scar adherent to the sclerotic.

Roughly, the question of securing exactly the desired wide fold of iris lies almost entirely in the control of the pupil at the time of operation and for some hours afterwards, using only cocaine and adrenalin for dilatation and eserine for contraction. If eserine solution stronger than $\frac{1}{4}$ per cent. has been used on the day of operation, there

may be tedious waiting for its effect to be overcome. Some enlargement of the pupil is needed to allow the iris to be drawn easily into the sclero-corneal wound, and for it to remain there; but wide dilatation is to be avoided for the first twenty-four hours after operation. A much narrowed and slackened iris tends to uncurl (Fig. C), with leakage of aqueous in front of it, as in Borthen's iridotasis. From this may follow irremediable conjunctival vesiculation and complete alteration of the whole character of the treatment—complete loss of protective fibrosis. Even short of this, experience has shown that early wide dilatation of the pupil may limit bulging of the prolapse sufficiently to prevent the desired adhesion between it and the overlying conjunctiva. Without moderate bulging also the friction against the upper lid which is conducive to fibrosis is reduced, as is also presumably the stretching of the loop of iris which is needed for the development of the essential marginal filtration.

A small fold of iris lying in the sclero-corneal wound may often be widened by repeated pressure on the eye through the lower lid within an hour or two of the operation. There is no need to bandage the eye; a shield is sufficient protection. Too small a prolapse may fail to relieve tension, or may relieve it only through the formation of most undesirable superficial openings in the iris. If the prolapse remains small, persistent recurrent tension, or a tendency to the formation of dangerous leaking points, may indicate the need for a small supplementary operation to draw up more iris.

In a few very advanced glaucomas even a wide typical prolapse has failed to filter sufficiently early to prevent troublesome return of tension, necessitating one or more sub-conjunctival incisions of the prolapse with a Graefe knife. The same incisions may be needed a fortnight or more after operation, for excessive bulging, and particularly for uneven bulging, of the prolapse, which by localised stretching may be tending to the formation of stomata.

The site of a basal opening in the iris, a consequence

of some former operation, need not be avoided altogether in operating by this method, but the wound should be placed so that the basal iris opening shall be near one end of the prolapse. The method is inapplicable where a wide iridectomy has already been performed.

Protective fibrosis.—In this country the migration of uveal pigment into the surrounding conjunctiva is rarely noticeable as it is in India. It is important to realise that the fibrous tissue formation, which in typical cases covers the whole prolapse, is largely conjunctival—that is to say, in addition to the fibrous change in the superficial iris, there is a definite layer of new tissue laid down in the covering conjunctiva (Fig. B , forming a protective shield. This has been very noticeable in two cases in which adhesion of the conjunctiva to the iris was imperfect. At one or more points the rather thick new conjunctival layer of tissue presented a sharply defined margin.

The conjunctival development is accompanied by the formation of large tortuous blood-vessels over and near the swelling.

The value of the treatment must be determined mainly by the two vital questions—(1) of the completeness and permanency of the relief of tension provided, and (2) of safety in the matter of late infection.

Complete reduction of tension.—It must be clearly recognised that in a few of the severer chronic glaucomas full relief from abnormal tension is obtained by this method much less quickly and less easily than by some other iris-inclusion operations.

In one nearly blind eye of the present series the pupil was rather widely dilated from chronic glaucomatous changes. The inelastic iris failed to filter afterwards and the tension remained high, with loss of the very small remaining portion of the (outer) field of vision. Such cases are unsuited to this treatment.

It is in the *permanency of relief* of tension that iris-inclusion operations in general stand out pre-eminently. And as yet I have seen no reason to fear that by this

particular prodecure the full reduction, when once satisfactorily obtained, will not be absolutely permanent. Such a statement cannot be made of many iris-free leaking cicatrices.

In 1903* I reported upon 130 prolapse operations of various kinds, and since then have performed some hundreds of such operations in India. Yet the only late return of tension which I can remember among them all was in an eye with rigid atrophic iris, in which massage and eserine had been needed for over two months after operation. However freely one may discount the value of Indian experience in late results, this experience of mine must carry some weight.

As serving to emphasise the above statement, I may add that during the last two years in this country I have come across thirteen instances of late return of tension after iris-free operations. Care was taken to exclude cases from the list in which it seemed possible that the effect of the operative treatment might have been insufficient from the beginning. Apparently after periods of effectiveness varying from three to eleven years, the drainage, though still going on, was no longer sufficient. Five of the scars were of the truly filtering type; the remainder were judged to be at least partly fistulous, the fistulæ being probably all small. These results appear to be much the same as with successful classical iridectomy, judging from old accounts.

Safety as regards late infection.—In this respect subconjunctival prolapses in general differ enormously. They may be classified more or less definitely in the following groups:

Grade I: The fully fibrosed prolapse stands well above all others. Its margin forms an extended filtering line well removed from the conjunctival limbus. The protective fibrous covering may become as white and as dense in appearance as the neighbouring sclerotic. Why should it not resist the penetration of conjunctival organisms equally as well? If it does so, the fact that it is directly

* *Trans. Ophth. Soc. U.K.*, 1903, p. 324.

continuous with the underlying uveal tissue is of no consequence.

My own feeling is that this type of prolapse is free from serious infective dangers of all kinds, and that it provides the best possible result in all eyes requiring freer drainage than is afforded by true iris-free filtering scars; that it ranks in safety with the latter, well above all iris-free fistulisation.

One cannot at present be sure of obtaining this result, but in an eye with intact iris one can, I think, by ordinary simple technique feel assured of obtaining at least nothing worse than one of the next grade conditions.

Grade II: Fibrosis defective, but conjunctiva free from any trace of vesiculation. (*a*) This sub-section differs from Grade I simply in the fact that fibrosis remains more or less wanting, possibly from undue stretching of the iris loop. In these wide prolapses the defect occurs only at one or both ends. Any leakage which may take place through the dark iris is too slight to produce any visible effect on the overlying conjunctiva. (*b*) Conjunctiva not adherent to the prolapse, but diffusely opaque, partly from fibrosis, partly from œdema. I have not been able always exactly to define the causes of this condition. Possibly one ought always to secure early bulging of the prolapse, if necessary by repeated pressure on the eye, and by control of the pupil shortly after the operation. And I think the sclero-corneal section should be as close as practicable to the limbus of the conjunctiva.

These results seem to me equal to the best obtainable from iris-free fistulisation (see below).

Grade III: Vesicular conjunctiva from the unrolling of the iris, as in Borthen's iridotasis, or from one or more openings in the iris. Such cases correspond with iris-free fistulæ, covered by similar blebby conjunctiva.

Grade IV: I well remember a rather small accidental prolapse in India, through a sclerotomy wound, in which a most dangerous-looking stoma formed beneath adherent conjunctiva. There was a round, dark, central area,

from which the conjunctiva seemed practically to have disappeared, surrounded by an opaque whitish lip, apparently of sodden epithelium. Such a condition seems to me more dangerous than any of the ordinary developments from iris-free fistulæ. Nowadays I should cauterise beneath the stoma and establish drainage elsewhere.

(A case was shown of an imperfect iris-opening, without appreciable change in the covering conjunctiva, at one end of an otherwise fully fibrosed prolapse. This end of the iris loop had been forcibly stretched in a perhaps unnecessary attempt to localise the prolapse, to avoid a very small conjunctival puncture at the other end of the sclero-corneal incision.)

I believe that in this operation Grades III and IV are entirely avoidable by simple technique. But until one can be quite sure of this, one wants to know what is the worst that may happen—what dangers one may possibly incur. This brings us to the question: What is known of the late infective risks of subconjunctival prolapse in general?

The question of possible *sympathetic ophthalmia* is the first consideration.

The shadow of sympathetic losses has lain heavily over the early history of iris-prolapse. From our earliest days the fear of this disease has been so ingrained in us that now it is apt unconsciously to warp our judgment. We are unwilling to admit that the old observations on iris-prolapse are perhaps worse than useless in the present connection; that they are misleading. But there is no doubt that the old prolapses were mostly, if not always, imperfectly covered by conjunctiva, since operations were not then performed with conjunctival flaps. There are no statistics, and there was no attempt to distinguish between covered and uncovered incarcerations. The only fair plan, therefore, in dealing with any particular type of prolapse is to start with a clear slate, and to collect new and precise observations.

My own experience, mainly Indian, of iris-displacements

of all kinds has been very large. I have seen them associated with sympathetic ophthalmia only under two conditions: either (1) the iris was partly or entirely uncovered by conjunctiva, or (2) there was strong presumption that the disease was introduced at the time of operation or accident. In these latter cases the evidences of early infection in the exciting eye were undoubted, though sometimes of slow development, and there was no very prolonged interval before the sympathising eye was affected. The operation cases were doubtless preventable by preparatory conjunctival antisepsis.

I have never seen sympathetic disease developing as, or from, a pure late infection from a prolapse or incarceration fully covered by conjunctiva, however vesicular the covering may have become. If this experience holds good, it removes the only fundamental objection to iris-inclusion operations in general.

Since sympathetic disease has occurred from sub-conjunctival rupture of the normal eye, one may suppose that this event may possibly follow less severe injuries in eyes with sub-conjunctival prolapse; but here one is getting to rather remote contingencies.

As regards the usual late *infections confined to the one eye*, it is apparently necessary to insist that sub-conjunctival prolapse "looks worse than it is." Here, again, one's judgment is apt to be affected subconsciously: one feels instinctively that the very obvious uveal displacement is wrong. But actually I know of no evidence to show that the late infections of iris-inclusion are more frequent or more severe than, or of different type from, those of iris-free fistulæ. Apparently there is no evidence that the presence of iris under the conjunctiva counts, apart from the fact that it keeps the deep wound open. Apparently the position, size and patency of the opening, and the consequent conjunctival changes, may be the only factors of importance in this connection.

Emphasis has been laid upon the finding of impacted uveal tissue in the trephine holes of eyes excised on

account of late infection. The impacted iris or ciliary body has been regarded as possibly the conducting material by which the organisms had entered the eye. But I. the balance of the histological evidence in the excised eyes seems to have been strongly against this supposition. The impacted uveal tissue could hardly have served to carry the infection inwards without some strongly suggestive evidence of this to be found in changes produced in the impacted tissue itself. And one might well expect also that the wide-spread changes within the eye would belong to one of the particularly uveal types of inflammation. But I understand that neither of these anticipations has been realised. The infections have been of the ordinary septic endophthalmitis type, with exudation on the surface of the coats of the eye.

(2) For the production of this common septic inflammation we know how entirely unnecessary is uveal impaction. We know how anything that keeps an old wound open may serve, and how readily recent wounds entirely unconnected with the uvea may become infected.

One may add also (3) that one does not know in how large a proportion of uninfected trephine holes similar impaction of iris may exist unseen. And (4) the exposure of uveal tissue in trephine openings is necessarily small as compared with that of many deliberately produced prolapses. If the sepsis travelled inwards by means of this uveal tissue late infection ought to be relatively frequent and grave after such operations as Borthen's iridotasis, and perhaps after some of my own operations. But the available evidence does not, I believe, lead to this conclusion.

In conclusion, the weakness of the main argument of this paper is that it is largely defensive. Too little is known of the subject; extended observations are needed. But perhaps enough has been said to dispel some of the prejudice surrounding all iris-inclusion operations, and to warrant the hope that by this particular method the defects of iris-free fistulisation may be largely avoided.

Mr. G. F. Alexander said one of the objections to the trephining operation was the frequency with which the trephine aperture became blocked by iris tissue, the ciliary body, or the lens. He asked whether the last two accidents were likely to vitiate the effect of Col. Herbert's operation.

Mr. Gray Clegg said he had done a large number of the trephine operations; if uveal tissue remained in the wound it had sometimes given him trouble afterwards, whereas when a neat peripheral iridectomy was done in addition to the mere trephining this was not unusually the case. In Col. Herbert's operation the iris was not damaged in any way, and that might account for a difference in the success of his operation even with iris prolapse. In one case there was a little attachment of the lower part of the small peripheral coloboma of the iris. It was an eye which he had to remove. Therefore he had been afraid when he had seen iris tissue impacted in the trephine hole.

Mr. R. R. James asked how long Col. Herbert had been performing this operation. He (the speaker) had himself no experience of it, but he saw Col. Herbert's cases that afternoon. His own fear about all iris-prolapse operations in which the iris was caught in the wound was the onset of sympathetic trouble. Col. Herbert had said that sympathetic trouble was very rare; he (the speaker) believed it to be now rarer than it used to be said to be. He had only once seen sympathetic trouble after a glaucoma operation, but it was known that sympathetic was capable of developing at a considerable interval after operation or injury. That was his reason for asking how long Col. Herbert had been doing this operation. In the case he (the speaker) referred to the sympathetic trouble came on almost at once; it was after a Lagrange, and the whole ciliary body prolapsed in the wound; the ciliary body was largely uncovered.

Mr. R. R. Cruise said the operations as seen that afternoon at St. Thomas's gave one an unsatisfactory feeling that it was a somewhat uncontrolled operation. The

appearances of the cases differed considerably the one from the other, and he knew Col. Herbert himself was not entirely satisfied with the cases he showed that afternoon. The amount of prolapse and the after-effect of the inclusion of the iris seemed to be lacking in consistency. Also one had the feeling that there was a direct tract of infection to the interior of the globe by means of tissue covered only by conjunctiva. He saw the connective-tissue thickening described, but there were one or two cases which had only a thin covering of conjunctiva, which constituted the only direct protection against infection from outside. For many years he had been doing Col. Herbert's operation of flap sclerotomy, modified by the fact that he deliberately kept the flap open for several days. He expressed the anterior chamber under the conjunctival flap and forced up the little trap-door to prevent immediate healing, and in his experience the results had been extraordinarily satisfactory. His cases had not all been successes; there was no operation of which that could be said. Most of them, however, had been so satisfactory that one got a diffuse filtering scar. No case had come under the microscope yet to see whether there were minute fistulæ. He looked upon it as a fistulous or leaking cicatrix, or, at any rate, a cicatrix which allowed the effusion of fluid from the anterior chamber. He had had to do three or four cases a second time, but he had no fear of these cases healing up again once they were satisfactorily established. He had had them going ten, eight, seven years, and they gave him no anxiety. Still, his patients reported themselves once a year, because he liked to see them. One or two cases in private and some hospital cases had sealed up afterwards, but one could perform the operation again. It was a very gentle form of damage to the eye. In the last six cases he had purely as an experiment tried to keep the trap-door open by a wedge consisting of a piece of iris tissue. He did a flap sclerotomy, excised a button-hole in the periphery of the iris, and as a final stage of the operation utilised the

excised portion of iris (which had been placed in warm saline) as a wedge, by placing it in one of the vertical cuts that formed the flap in the sclera, the idea being that a piece of the patient's own tissue—the iris—completely severed from the rest of the uveal tract should act primarily as a wedge to delay rapid union, and secondarily as a filtration channel. Those six cases in which he had done it had certainly filtered very satisfactorily. Of course they might have filtered without it.

The PRESIDENT (Mr. J. HERBERT FISHER) said he thought it was fair to Col. Herbert that such testimony as could be advanced in favour of that gentleman's small-flap drainage operation ought to be brought forward. Mr. Cruise had just mentioned with satisfaction the results he had had by that method, and he (the President) was inclined to confirm the favourable impression of the small-flap sclerotomy, which, he thought, had never been given the full credit due to it. He (the speaker) had performed the operation, and continued to do so for a considerable time after his colleagues at Moorfields had abandoned it in favour of a trephine operation. He ultimately gave it up as a routine operation, replacing it by trephining. He had seen, as Mr. Cruise had, cases ten years after, with satisfactory permeation of scar taking place, with adequate drainage, and a very satisfactory reduction of tension. He had had no experience whatever of iris-inclusion operation.

With regard to the chances of late infection in such cases, or the chance of sympathetic inflammation developing, he thought a line as to that might be obtained if one took into consideration the results which followed any sub-conjunctival rupture of the sclerotic, such as usually took place just beyond the corneal limbus, and in which the uveal tissue was not very infrequently included, and allowed to heal after the rupture. He was not aware that those cases were particularly liable to be followed by any sympathetic trouble in the other eye, provided the whole was a sub-conjunctival injury and there had been

no rupture of the more elastic conjunctiva over the scleral rupture. He presumed that, working on antiseptic or aseptic lines, the inclusion operation which Col. Herbert was advocating and performing would be fairly comparable with such rupture. In both, uveal tissue was included sub-conjunctivally. It was true that in cutting the conjunctival flap there was a source of intra-ocular infection, which did not exist when the rupture was sub-conjunctival throughout; but with the antiseptic precautions which were adopted the temporary chances of infection would pass in a short time, and the chances of late infection or of the development of sympathetic inflammation might be expected to be comparable in the two conditions. Surgeons had not a vast amount of material from which to deduce the chances of serious trouble taking place from a deliberate iris inclusion. It seemed to be fairly exclusively in the hands of its inventor at the present time.

Mr. R. R. Cruise, referring to the President's remarks, said the only case of sympathetic trouble he had during the whole war was in a case of sub-conjunctival dislocation of the lens with ruptured globe. Seven days previously the globe was ruptured, and the man did not pay much attention to it. The only treatment consisted of bathing the eye. The man was admitted to the Third London Hospital, and in four days he developed sympathetic trouble. The sympathising eye quieted down under injections of galyl, and normal vision was regained, though when last seen there was a fine haze in the anterior part of the vitreous.

Col. Herbert, in reply, said he had omitted reading the paragraph of his paper referring to the question of sympathetic trouble after sub-conjunctival rupture of the globe simply in order to avoid occupying the meeting too long. These cases were rare, but a number of such cases had been collected. Presumably in these cases the conjunctiva was damaged sufficiently at the time to allow organisms to pass through.

Mr. Gray Clegg mentioned damage of the iris in his case of inclusion, which got infected. He (the speaker) agreed that any damaged, bruised or torn iris, or even a stretched iris, was liable to become infected when an undamaged iris would not. Possibly in Mr. Gray Clegg's case the infection was introduced at the time of the operation. Mr. Clegg did not say what was the interval of time afterwards. (Mr. Clegg afterwards agreed that the infection probably was a primary one.)

In answer to Mr. Alexander in regard to advance of the lens, one point about these operations was, that the anterior chamber was refilled at once ; it was a point in connection with the safety of the operation ; advance of the lens hardly ever took place in it.

In reply to Mr. R. R. James, the first operations of the kind he did were at the beginning of the century, in 1900 or 1901, but he never went on with them systematically, though he had constantly returned to other iris-prolapse operations at intervals. He had avoided this particular operation simply because of the bulge; it was an ugly thing, and he did not know in early days whether it would subside. As a matter of fact, if the tension was reduced fully one could rely on the bulge subsiding gradually.

Mr. Cruise had mentioned variability in the results shown. He confessed that his results had been very variable, more so with the cases he had done in this country than with those done in India, where he did the operation frequently in war-time. The difference was due to variations in technique. He now had what he thought to be the best technique. Sometimes he had used a narrow knife, sometimes a keratome, and he had varied in regard to the use of drops before and after the operation, and he had given his impression of what should be done now, and what results were easily got now. His results had not always been as good as they might have been, because of these variations in technique. Mr. Cruise thought there was a possibility

of infection travelling inwards; but his (the speaker's) experience was that it did not. It was simply a question of experience, and there had not been a very large amount of it as yet. The iridotasis operation had been done in hundreds of cases, and the published reports of that were surprisingly good, though there was not the same protection against late infection as in the operation now being discussed.

Referring to the cases in which he had seen a late return of tension after iris-free filtration, they occurred among about a hundred old glaucoma cases, seen five years or more after operation. He hoped to publish an account of them.

He had no wish to push this particular operation, but he wanted to dispel some of the prejudice which still surrounded all iris-inclusion methods.

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2. *The rational treatment of glaucoma.*

By T. Harrison Butler.

The rational treatment of any disease should depend upon a correct appreciation of its causes and pathology. In the case of glaucoma we are to a large extent reduced to empirical methods because the actual cause is unknown, and there is still considerable difference of opinion as to the significance of the changes discovered in the glaucomatous eye. Some of the abnormalities which in the past have been regarded as causes are almost certainly effects, and others which are generally associated with glaucoma are to be found in normal eyes and may be entirely absent in manifest glaucoma. For the present, then, we are unable to base our treatment upon pathology and must make the best of our empirical methods.

A rational empiricism must be founded upon accurate observation of the disease before and after treatment, upon the most careful study of a large number of cases

which have been thoroughly examined before any line of action has been adopted, and upon the results of subsequent observation extended over a long period of time. Further, it is necessary to treat series of cases by different methods, and to compile statistics from time to time, which will afford a comparison between the effects of rival methods. These statistics may reveal sources of failure, and when these errors of technique have been corrected a second series should yield a higher percentage of success. As an example, I found that in one series there was a high percentage of cases in which the trephine hole healed up, with consequent failure of filtration and rise of tension. I enlarged my opening by using a 2 mm. trephine instead of a 1·5 mm. The result was that in the next series this source of failure almost disappeared.

Finally, rational treatment will depend upon the experience of others, and especially of those who worked in the pre-tonometric age, only when such observations have been personally confirmed in the wards, the operating theatre, and the out-patient department. Respect for "authority" is a clog to progress; prejudice and preconceived notions delay the advance of real knowledge. I well remember that when I was a surgical dresser a surgeon from New Zealand visited the Hospital and told us his experiences of practical surgery. His advice was, "Burn your text-books and study the patients instead." I have an idea that he also advised us to regard the teaching of our eminent surgeons with suspicion. We amused ourselves by filling his top-hat with iodoform, but I shall never forget his advice, "Burn your text-books." Certainly as regards glaucoma we may burn our pre-tonometric text-books.

The history of glaucoma may conveniently be divided into the pre- and post-tonometric ages, and these periods also synchronise with the time before and after the introduction of the filtering scar. Before the introduction of the tonometer we knew as much about the intra-ocular tension as was known about the body temperature before

the invention of the clinical thermometer. It is possible to feel the body of a child and to guess that the temperature is raised, but no self-respecting physician would found a diagnosis and base treatment upon a casual examination of this nature. The determination of tension with the fingers appears to me to be an exactly parallel case, and one open to similar errors. The hand placed upon the chest will in most cases detect a really high temperature, and the trained finger will often realise that an eye is hard or soft within fairly gross limits. But the sources of error in both instances are numerous. The thermometer and the tonometer give an exact determination of the departure from the normal. Personally I feel that the *tactus eruditus* is a very over-rated quality. On one occasion I presented a patient to the Midland Ophthalmological Society and his tension was estimated by about ten members. Some said it was raised, others that it was reduced by the operation which had been performed, and others again opined that it was normal. The tonometer at once showed that it was in fact normal. The sensitiveness of the finger varies from time to time. A cold finger, a tired brain, a moist or a dry atmosphere all have an influence, but the tonometer has no nerves. The finger feels three things: the lids with a hard tarsus, the eye and the orbital contents. A thick hard lid and an œdematous lid afford a varied sensation. An eye proptosed by Graves's disease feels hard, a sunken eye in an old woman with little orbital fat gives the sensation of softness. In a word the sources of error are so great that I accept no opinions upon glaucoma that are not founded upon tonometry. The essential feature of glaucoma is rise of tension, and if we are to attain to any rational treatment of the disease we must have an accurate knowledge of the degree and the variations of this rise of tension. The tonometer must be employed frequently before and after operation, and it is rational to chart the tensions as we do temperatures. I make a practice of charting the tension, and since I have done so I have

found it much easier to study the course of the disease. Rational treatment must depend upon a rational diagnosis. In the case of acute glaucoma this presents few difficulties, and it is not necessary to describe the well-known signs. Chronic glaucoma is more subtle, and it is here that the tonometer is so necessary. Briefly the diagnosis depends upon three factors: the appearance of the disc, the nature of the field of vision, and the verdict of the tonometer. In my experience the disease which is most liable to be confused with early glaucoma simplex is retro-bulbar neuritis. A case of my own was diagnosed as tobacco amblyopia by a careful and expert surgeon, but it proved to be glaucoma. The appearance of the discs may lead to error. A deep cup extending to the edges and well undercut may be present without other signs or symptoms of glaucoma, although, as pointed out by Hugh Thompson, such a disc is at least suspicious, and the eye is perhaps liable to become glaucomatous later on. In pre-tonometric days it was held that glaucoma can exist without tension. The cupping is said to be due to a cavernous atrophy, and it may go on to complete blindness without any rise of tension. I have myself seen some of these cases, and I have examined sections of the disc which show the cavernous atrophy. Since I have made a practice of the routine and constant use of the tonometer I cannot recollect a single case of this kind. I think that probably there are such, but they are few. On the other hand I feel sure that the disc in glaucoma simplex is not normal, that it is far more easily cupped than a normal disc. A deep cup may rapidly appear in eyes with but moderate rise of tension when they are affected with glaucoma simplex. On the other hand, in acute glaucoma the tension may be very high and may continue for a long time, and yet the disc does not become excavated. I have no doubt in my own mind that we are dealing with two entirely different diseases which have but this in common—that the tension is raised. In fact I think that in some cases acute glaucoma may be a mere

accidental formation of a vicious cycle in an otherwise fairly normal eye.

Examination of the fields of vision both as regards the periphery and the centre is of supreme importance. During the past ten years perimetry has become almost a science in itself, and the number of perimeters and campimeters is legion. Personally I think that any variation which cannot be detected by the ordinary Priestley Smith perimeter and a simple velvet screen is of little clinical importance in glaucoma. The Priestley Smith instrument has the advantage that it is cheap and that the object is carried on a rod. The patient is, in consequence, not confused with the carrier. This perimeter is semi-self-registering, and the time taken is but a few seconds more than with a McHardy. Five minutes spent with the simple Bjerrum screen will show whether the blind spot is enlarged, or reveal the presence of a para-central scotoma. In hospital practice and in busy private practice there is no time for the employment of the modern elaborate methods. It is far better to concentrate upon simple practical examinations and to carry them out frequently. If the rapid Bjerrum examination reveals any abnormality the scotomata must be accurately mapped out, and this is certainly a matter of time, but it is time well spent. In my experience the Bjerrum scotoma is often absent, but when it is found it is of vital importance. I have a patient in whom the signs of glaucoma are not marked and the tension is only about 30 Schiötz units. There is, however, a well-developed Bjerrum scotoma which menaces the fixation spot although the peripheral field is normal.

Treatment.—During the past year I have entirely changed my treatment of acute glaucoma in that I rarely operate upon the patients in the acute stage. I find that the majority of the cases quiet down rapidly under suitable treatment and then it is far easier and safer to operate. I put the patient to bed, give him a free purge, and instil a 1 per cent. solution of eserine sulphate every

two hours. A hot box is applied and morphine is injected if the pain be great. After about a week, or even less, it is possible to perform iridectomy without a general anæsthetic. I have practically abandoned the orthodox operation in favour of what I call trap-door iridectomy. This consists in trephining with a 1·5 mm. instrument and leaving the disc with a hinge. The iris prolapses or is drawn out, it is excised, and the trap door is closed. This method appears to have many advantages. In the first place the iridectomy is really peripheral, and yet the incision is small. This I regard as fundamental. It is irrational and dangerous to make the large keratome incision or the Graefe section called for in the classical operation when the same object can be attained with a small orifice. Again, there is no subsequent astigmatism; and one may occasionally get a little useful filtration of a permanent character. So far I have found the operation easy and successful. The chief advantage is that there is no danger of wounding the lens. At one time I made light of this danger and put accidents of this type down to faulty operating. Pride had a fall, for I had in one year two cases of localised cataract after iridectomy. In neither of these do I think it possible that the lens capsule was touched with the point of my keratome. I imagine that the damage was done with the iris forceps. It may be that in the acute glaucomatous eye, which is acutely congested, the capsule is friable and is more readily wounded than in a normal eye. As a matter of fact there is always a chance that the capsule may be damaged when an iridectomy is performed in the acute stage of glaucoma. This danger is avoided by waiting till the eye is quiet and then operating by a trap door. As far as I can see there are no disadvantages. Not infrequently when the acute glaucoma is of long standing, and almost always when it is an exacerbation of a chronic state, the iridectomy fails to normalise the tension. The eye may and in fact generally does quiet down and the patient is comfortable, but the tonometer shows that

the tension is still raised. It may have been reduced from, say, 60 Schiötz units to 30. This partial failure may not be obvious to the finger, but the tonometer shows the danger. In such cases it is necessary to perform one of the fistulising operations.

I take it that except in matters of detail there will be little difference of opinion as to the correct treatment of acute glaucoma. In the case of the chronic variety, glaucoma simplex, there is no such unanimity. Not only do we discuss, sometimes even with some heat, the choice of method, but I note with dismay that there is a tendency to revert to mediævalism, and at the last Congress of this Society Mr. Rowan read a paper which opened the door to a discussion upon the so-called conservative treatment of glaucoma, during which the non-operative treatment received considerable support. Both in America and in Germany papers which advocate the non-operative treatment have been published. The universal reason given for non-interference is that some eyes have lasted for years without any operation, and that others have lost sight after operation. It is obvious that we must approach the subject from two sides. Shall we operate at all, and how and when shall we operate?

There are two vital facts which have, I think, now received universal acceptance: hypertension is the cause of the deterioration which, slow but sure, is observed in the glaucomatous eye; and secondly, the earlier the operation the more certain the cure. There is yet another equally vital fact which has so far not been universally accepted: it is that in the vast majority of cases the progress of the disease is absolutely stopped for so long as the intra-ocular tension remains normal or subnormal. Of this I personally have no doubt whatever. I can produce a large number of cases trephined by me and by colleagues which I have watched for years—in some cases for eight and even ten years—which have been permanently cured, in that the symptoms have disappeared and the signs have remained stationary. In not a few

there has been a marked improvement in vision and in size of field, but in the majority there has been no change; as the eye was at the time of the operation so it is now. This happy state of things persists only so long as tension remains normal. If, owing to failure of free filtration, the tension rises, then the disease begins to advance again and a second operation is called for. It does not follow, because the glaucoma is cured, that in a small majority there will not be a gradual failure of function. A glaucomatous eye may be a sick eye—one liable to degeneration. We often see a slowly growing nuclear cataract or senile changes at the macula. These complications will occur whether we operate or not. I say advisedly that the glaucomatous eye *may* be a sick eye. This is by no means always the case. It is often a hard eye and nothing else. As soon as it is made soft it appears to be perfectly sound. I do not think that I need advocate early operation. It is almost universally agreed that the earlier we operate the better. My own experience is overwhelmingly in favour of the early operation. During the last three years I have trephined over fifty eyes for glaucoma simplex. Practically all have been attacked as soon as I was convinced that I was faced with a progressive disease; most of the cases were trephined within a month of the first examination. The result is that all have as far as I know been successful, except two which had to be trephined again. In no case has there been any marked loss of vision after operation, and not one has caused me any anxiety. My opinion is that the bad results which so many operators have noted have been due to a postponed operation, and perhaps, in some of the published cases, to defective technique. I read in American papers accounts of, say, ten operations. I think that it is necessary to perform about one hundred trephinings before the best results are obtained. It is not an easy operation. Anyone can make a hole in an eye, but a neat and successful trephine operation is the final stage of a long apprenticeship.

In Germany late infection has led to a return to miotics or to iridectomy. Late infection is a bogey. I have had one case, a mild one in 160 operations with the trephine. With the punch I got 20 per cent. and lost three eyes. Cases will occur from time to time, but with a correct technique they will be so rare that they need not influence the surgeon in his choice of treatment. Far be it from me to advocate operation in all cases. We must be rational and use common sense. I have a patient who, in spite of the use of miotics, has a continued high tension in one eye. He is not young, he has an open discharging fistula from a nephrectomy operation, and he has a second apparently sound eye. He is very nervous, and does not want any further operation. I do not blame him, and if I had had my kidney out I should feel the same. In his case the field is full, and the sight normal. There is a dangerous Bjerrum scotoma and I believe that one day he will find that he has lost central fixation. But he will still have a second eye to go on with, and it will probably last him as long as he wants an eye. If I operate on a septic man I may easily get a panophthalmitis. Again, there appear to be eyes which tolerate a raised tension, say of 30 units. These are the cases which do well with miotics and would, I think, do equally well with distilled water.

My view would be to operate at once upon a hospital patient as soon as it is seen that the tension is raised, and that there is loss of function either as regards field or acuity. If the disc be cupped I would not even wait for loss of function. A private patient is not so likely to neglect his eye and may be watched for a longer period. There is, however, a danger in waiting too long. I have seen a case which appeared to be going on well rapidly lose his field in a very short time. Nor can we disregard the fact that some of these chronic cases may suddenly become acute.

Ought we to operate when the field is contracted towards the fixation point? Here, again, I believe that

we are dealing with another bogey. The nearer the scotoma is to the centre the more dangerous the case, and logically the more the call for relief of tension. In such circumstances I advise operation at once, and if there be only one eye I urge it the more. I have only twice seen loss of central vision after operation, but I have seen many cases which have lost this function from delayed operation. In this type of case central blindness is almost certain in a very short time, but the majority have in my practice been saved by immediate operation.

I operate upon every case of chronic glaucoma as soon as I realise that there is loss of function unless the general circumstances, age, health of body and mind or social conditions contra-indicate an operation. Up to the present I have seen nothing to lead me to modify my practice.

What operation are we to adopt? The answer must be, that operation which we have brought to perfection, and which has given us good results after we have tried others and found them less effective in our hands. Iridectomy has had a long run. It yields a percentage of at most 45 per cent. of success, but it has now been superseded by better methods—methods which may give a percentage of about 80 per cent., if performed early in the disease, and at least 70 per cent. in all cases. All these operations aim at the establishment of a filtering scar, and many of them attain this object. I personally have had the best results from the two-millimetre trephine; my friend Mr. Cridland gets equally good statistics from Lagrange's operation. Mr. Jameson Evans pins his faith on the Herbert wedge isolation method, and Mr. Cruise tells me that he obtains the best results with a modified Herbert trap-door operation. There are many other ways by which a filtering scar may be produced, and I think that not one of them is ideal. It is manifestly unsound to concentrate filtration into one spot as in the trephine operation. The continued hydrostatic pressure tends to produce an ectatic scar

which is unsightly and sometimes uncomfortable. Quite a large proportion of these operations sooner or later show this undesirable condition. The rational filtration scar will be an extended one with moderate permeability all along its whole extent. So far no operation can be relied upon to produce this effect with any certainty. It is not infrequently seen in an old iridectomy scar and it then forms the ideal condition for the reduction of tension.

My chief experience has been with Holth's punch operation and with the trephine. I have entirely abandoned the first method because it is so liable to be followed by late infection. The trephine gives me excellent results, and during the past three years I have had the good fortune to see no serious complications. Iritis has been mentioned as a frequent sequel, but the routine use of atropine renders any slight iris congestion harmless, and I now rarely see any synechiæ after the operation. The eye should be regularly massaged after the operation, and this should be continued till free filtration is established. In some cases massage must be persevered with for months.

I greatly fear that my remarks have been dogmatic, but my dogmatism is founded upon the careful study of over two hundred operations.

Mr. Stack desired to thank Mr. Harrison Butler for his advocacy of tonometry. Perhaps it was unnecessary at such a meeting as this, but one had to advocate a thing which one thought good to a great number of people besides ophthalmic surgeons. The instrument was gradually becoming general, but there were many who, although they believed in the tonometer, did not use it sufficiently. He asked whether Mr. Harrison Butler had had any bad results from 4 per cent. cocaine; he (the speaker) used that before putting on the tonometer.

With regard to the operation, if one had established that there was glaucoma in both eyes, however slight, the right one to operate on was the good eye; that

should not be put off until the worse eye had been dealt with.

The President (Mr. J. Herbert Fisher) said the most remarkable case of palliative treatment of glaucoma short of operation which had come under his observation was that of a man, who must have been seen by some of his colleagues also, and who was told by the leading surgeons in this country, and some on the continent, over forty years ago, that he was in imminent danger of going blind. At that date, no doubt, he had conspicuous pathological cupping of both discs. The man did not come under his (the speaker's) observation until he was about seventy years of age; and during the thirty-five years before that time he was advised to have operation—at that date iridectomy—and he had suffered the subjective symptoms of glaucoma. When, in the evening, he had glaucoma rings, he put into his eye a very small portion of a single gelatine disc of eserine, rested twenty minutes on the sofa, and then he passed the evening comfortably. When Mr. Fisher saw him he had lost the peripheral field in the right eye, although he retained a vision of $\frac{6}{12}$ centrally. The other eye throughout, allowing for refraction, had $\frac{6}{6}$, a deeply-cupped disc, and a quite full field. Eventually, when he was in the seventies, this eye was beginning to suffer, and to show contraction in its field. He operated without delay as soon as it was evident that there was a definite encroachment on function, although he continued with palliative measures so long as function was unimpaired. He did trephining with an entirely satisfactory result eighteen months ago. He had suffered no further loss of vision, and the eye still had a full field with $\frac{6}{6}$ partly. Yet both discs were extremely cupped; there was pathological cupping which no one could help recognising. If he had seen that man earlier and did not know his long history, he would have advised operation without delay. The eye he operated on was the good eye, and during the period of convalescence, within twenty-four hours of the trephining, he developed an attack of acute glaucoma in

the unoperated eye and palliative treatment brought it slowly round. After the attack he had as good vision in that eye as before.

Mr. Harrison Butler (in reply) said he had seen bad results from the use of the tonometer in one case; a small corneal ulcer formed after using it, but it got quite well with proper treatment. The examination was made by his house-surgeon, and the patient kept moving her eye about. With regard to any sequel from cocaine, he used holocaine. Cocaine and eserine could be used, but the combination upset some nervous people.

3. *A gyroscopic trephine.*

By E. H. E. Stack.

Some time ago it seemed to me that it would be an advantage if a trephine could be made which would rotate so rapidly that the disc would be cut by a mere touch.

I first considered an electric motor which drives a wire as in a dental engine, but found the attachment hampered one's sense of touch. I next thought of a self-contained clockwork like von Hippel's, but it would not rotate fast enough.

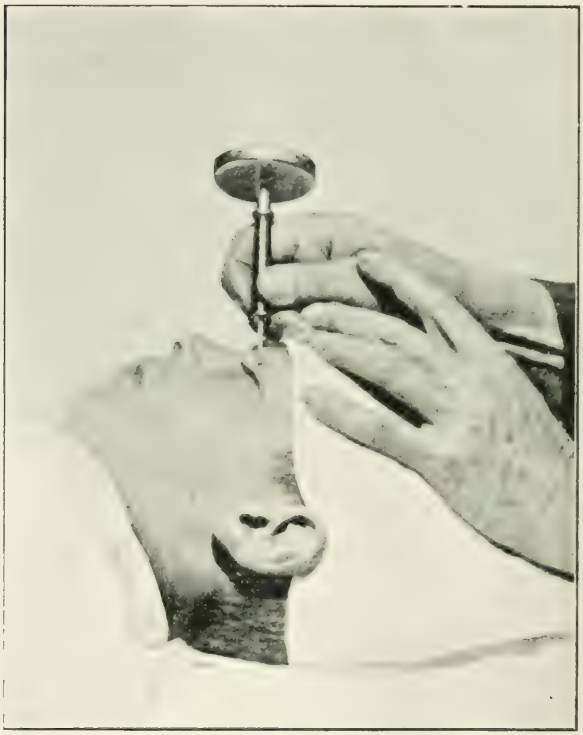
Finally I settled on a gyroscope, like the old-fashioned top, started with a piece of strong Pagenstecher's thread —a motor power hitherto, I believe, unused in surgery.

The gyroscope is boiled before use, which cannot be done in the case of the other two mentioned. It is composed of four detachable pieces, the spindle and fixing screw, the fly-wheel and handle; it is made by Weiss. It spins for over half a minute, and I am able to cut with one spin twenty discs in a piece of parchment, each with its little "epiglottis" on its hinge, so that although there is no time to waste, there is found in practice to be ample time to do the operation without any undue hurry.

The weight and spin of the fly-wheel enhance the steadiness and control.

The rate of rotation is about 1200 per minute.

Fig. 38.



The photograph shows the method of holding the trephine; a speculum has not been inserted.

The trephine stands on the table ready boiled and wound. The flap is held down out of the wound with a pledget of wet wool by an assistant.

The trephine is started by holding it rigidly in the right hand and pulling the string off rapidly and cleanly with the left.

The assistant gives a final swab if necessary on the selected spot. The hand is placed on the forehead and the trephine at an appropriate angle touches the spot.

The disc is cut absolutely instantaneously. There is no pressure required; the contact with the eye is unfelt by the operator.

A short or long disc can be cut according to the obliquity of the instrument, and a narrow or wide base can be left as a hinge to the flap, if a hinge is preferred; I always leave one myself. The upper edge of the cutter is seen all the time and is raised the moment it reaches the sclerotic.

The rapidity and the absence of pressure cause even less disturbance to the patient than the ordinary trephine. The hinge can be left at any point of the circumference. The left hand "stands by," the fingers touching the right hand to steady it.

Trephining with the hand instrument with practice is not a very difficult operation, but as a contrast to the gyroscope I may mention six points where it is at a disadvantage:

(1) It must be very sharp.

(2) The hand while using it cannot be steadied by resting it on the patient's forehead.

(3) Movements of the eye may necessitate taking off the trephine and then starting again; oozing then may cause a little difficulty in hitting the groove.

(4) The time taken to cut the disc, though short, is often enough to allow haemorrhage to obscure the cutting edge, and a complete disc may unintentionally be removed which may fall into the anterior chamber.

(5) It has happened, though I expect rarely, that the trephine has gone too deep and wounded the iris or even the lens.

(6) The necessity for fixing the eyeball is more important than with the motor trephine.

Compared with these the advantages of the rapidly-rotating cutter are:

(1) Even if not perfectly sharp it works equally well.

(2) The hand is steadied on the forehead, which gives absolute control.

(3) There is no time for movements of the eye to interfere with the operation.

(4) The disc is cut before blood obscures the edge of the trephine.

(5) The fingers of the steadied hand drop the trephine against the eye. The control is so simple, slipping or going too deep is impossible.

(6) The eyeball requires no fixation.

We never have to trephine a soft eye, but to demonstrate the cutting power of the gyroscope I often operate on one which is just going to be excised and find it easy, whilst with the hand trephine it is difficult.

In conclusion I can claim that the operation is easier, quicker and safer than with the hand-moved instrument, and that this is particularly the case with beginners.

There are two new features: the disc is cut instantaneously and the control is perfect.

The PRESIDENT said there was danger in cutting one's flap and button-holing it, and he wondered whether Mr. Stack found it difficult owing to the rapid rate of revolution at the moment of starting the motor.

Mr. D. WILSON said the trephine he had always used was one in which the whole handle had to be moved, and he asked whether there was a trephine designed on the model of a watchmaker's screw-driver, so that with the first finger to steady the top the shaft could be rotated with thumb and second finger.

Mr. G. F. ALEXANDER said there was one circumstance in which it was impossible to use the hand trephine. He had done an iridectomy for glaucoma, following which the lens was pressed against the cornea and kept there. He then did a posterior sclerotomy, proposing to trephine, but he found the vitreous being discharged in such a large quantity that he had to do otherwise as best he could.

In such a case one of the trephines now shown would have acted splendidly, as requiring little pressure on the eye.

Mr. STACK (in reply) said the need was for something which would trephine even a soft eye without pressure; that was achieved with a very rapidly rotating instrument. He had found no difficulty with regard to touching the base of the flap. It was generally tilted away from the flap, so that the lower side was resting against the flap. The base of the flap had never got in his way. At the clinical meeting Mr. Hudson showed a case of aniridia which had tension, and Mr. Hudson said he felt chary about touching it with a trephine, for fear of wounding the lens. But if one took the gyroscope trephine and tilted it on its side, as demonstrated, it would cut or groove the sclerotic easily, and one had such good control that one would not go half a mm. below the sclerotic.

4. *Note on trephining, and some instruments for the purpose.*

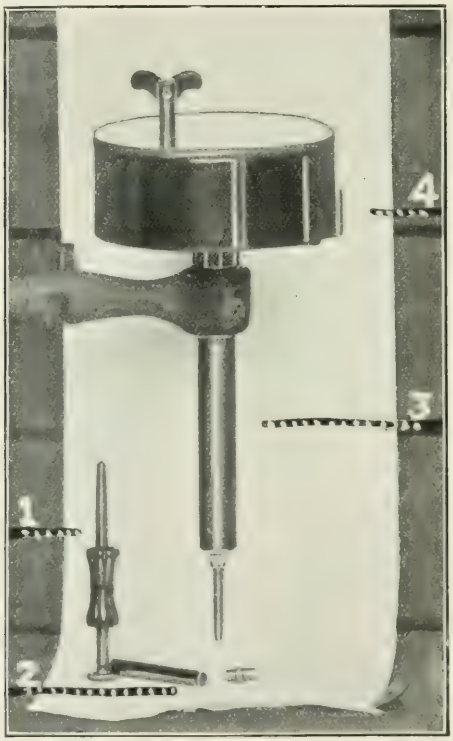
By GEORGE MACKAY.

My first efforts in trephining the sclerotic for glaucoma, made when Assistant Surgeon to the late Dr. Argyll Robertson, were performed with a Graefe's knife. A flap of conjunctiva was dissected back, so as to expose the sclera behind the ciliary region and between the inferior and one or other of the lateral recti muscles. A quadrilateral piece of the sclerotic from 2–3 mm. in length and breadth was excised, the choroid and retina were punctured with the point of the knife, and a large bead of vitreous allowed to escape before the flap was replaced and sutured. A little more vitreous was then expressed under the flap by gentle palpation until one was satisfied that there was an appreciable reduction of the intra-ocular tension. Temporary benefit was obtained, but the tension rose again

in a few days, when probably cicatrisation of the aperture plugged by vitreous and choroid must have occurred.

When in 1909 I casually met Dr. Freeland Fergus, and (prior to the publication of his paper) received from him

Fig. 39.



(I) A hand-driven corneal trephine with fixing point, and (II) a clockwork-driven trephine. 1. Ordinary corneal hand-driven trephine showing fine fixing point projecting from cutting aperture. 2. Adjustable protector beside it. 3. Clockwork trephine (held in metal support in place of hand for purpose of photograph). Winding key above, controller (for starting or arresting machine) at side of drum (4), and small adjustable protector below cutting edge of trephine.

the suggestion to try the effect of turning down a flap of conjunctiva over the upper border of the cornea and making the aperture at the corneo-scleral junction, it was

again with a Graefe's knife that my first operations were performed. The gratifying results obtained made me order a Bowman's corneal trephine from Weiss & Son, and to employ it thereafter. The difficulty of keeping the cutting edge of the hand-driven instrument from slipping to one or other side of the desired axis of rotation led me to insert into the hollow trephine a slender solid rod, made with a sharp point, which was allowed to project beyond the knife edge for about 1 mm. until the circular incision had been sufficiently established to steady the cutting blade in the sclerotic. The axial rod was then withdrawn to the level of the cutting edge, and eventually a little higher as the trephine proceeded through the thickness of the sclerotic.

As these adjustments are not easily made without raising the trephine two or three times from the surface, it occurred to me that a trephine, mechanically driven like a dentist's tooth-boring burr, would serve the purpose better. My dental hospital colleague, Mr. J. H. Gibbs, L.D.S., kindly took the problem in hand, but departing somewhat from my idea advised me in the first instance to try a clockwork mechanism, mounted above the trephine, and with the aid of Mr. T. Miller, philosophical instrument maker, we evolved an instrument now shown which closely resembles von Hippel's, but costs much less (namely, £2 10*s.* instead of £7). It works very fairly well, but is rather top-heavy. It is not easy to get a light clockwork mechanism placed in this elevated position of sufficient power and duration to carry through the operation without some interruption for rewinding, especially in a patient who is not absolutely steady.

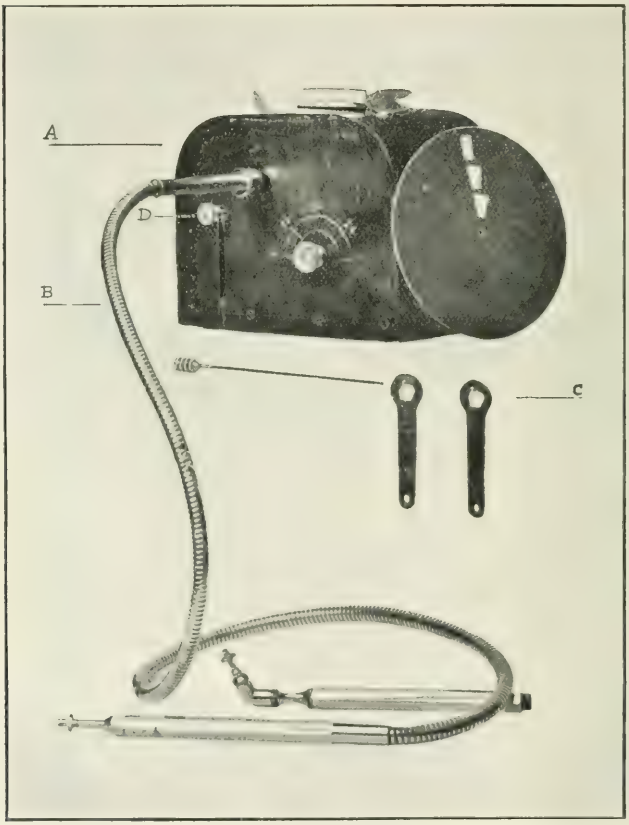
Reverting to my original idea, I then got Mr. Miller to construct for me the next apparatus exhibited (Fig. 40).

A dentist's drill is commonly driven by a small electric motor, but for our purpose clockwork as the motive-power seems simpler, more portable and less costly.

The apparatus shown consists of a clock taken from an Edison phonograph, enclosed in a metal case, but

modified in some internal details so as to occupy a smaller space. When fully wound it can run for three minutes.

Fig. 40.



(III) A clockwork-driven cable trephine. A. Modified phonograph clock in case with winding key resting on top, and controller projecting above. Rate of rotation indicator on front. B. Adjustable flexible wire cable for transmitting power to pencil-shaped or angled trephine as may be desired. Cross-shaped protector covering cutting terminal of each trephine. C. Pair of fenestrated keys for unscrewing parts of the trephine holders, and ramrod for clearing the bore of the trephines. If the cable be detached from the front of the clock-case, the Percival light-sense disc shown resting against the side of the case can be fitted on at D and set in rotation.

(2) A detachable cable of wires (B) enclosed in a flexible metal sheath conducts the rotating impulse to the pencil-like trephine holder. The weight of the clock rests on an elevated table; the greater part of the weight of the cord can be supported over the operator's shoulder or arm, but is better to be held by an assistant, who can also start or arrest the clock as desired without affecting the part of the instrument held by the surgeon.

Some surgeons are now employing the trephine not merely for glaucoma but other eye conditions, notably in the treatment of detachment of the retina. For this latter purpose the cutting edge may have to be applied as far back upon the sclera as possible. If this has to be done from the nasal side, the bridge of the nose may interfere with the application of a trephine at the end of a straight arm. To meet this possible difficulty I have had an additional holder made, to demonstrate that the power can be transmitted round an angle by a suitable adjustment.

Two keys are supplied for convenience in unscrewing and screwing up the component parts of the trephine-holder. These parts can easily be detached from the cable and separately sterilised.

I have discovered an additional use for the phonograph clock. By making another aperture in the metal case it supplies a convenient motor to set in rotation a Newton's colour-top, or the discs recently devised by Mr. Percival, of Newcastle, for testing the light-sense, and possibly other useful purposes may be served by it when not required for trephining operations.

On the anterior face of the metal case is a speed indicator. By this the rapidity of the rotation of a disc (D) can be controlled so as to be advanced from zero to approximately 25 revolutions per second if desired.

The spindle to which the trephine cable is attached rotates at about one-sixth of the rate indicated for the discs. Thus the cutting edge of the trephine makes approximately 4 revolutions per second when the point of the indicator is at its maximum.

The cost of the apparatus as made for me by Mr. Miller is £7.

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5. *Congenital aniridia treated by sclero-corneal trephining.*

By A. C. Hudson.

Hilda H—, æt. 7 weeks.

April 12th, 1921: Mother gives history of normal pregnancy and labour; no miscarriages. Eleven other children, all normal. Right and left aniridia; œdema of cornea, with dull fundus reflex. Intra-ocular pressure much raised (tonometry impossible).

April 15th: R. paracentesis. Cornea at once became transparent; no trace of iris visible.

April 22nd: R. corneo-scleral trephining, under chloroform and ether. R. cornea is now almost transparent, and although filtration of aqueous humour is not obvious, the intra-ocular tension is satisfactory and the fundus reflex of normal brightness.

X. MISCELLANEOUS.

1. *Punctate deposits on the retina.*

By Sir William Lister, K.C.M.G.

(With Plates V—VIII.)

Colonel Elliot has described "dots on the retina" in eyes in which cataract had been couched, and which were undergoing chronic inflammatory changes. He writes in his book, *The Indian Operation of Couching for Cataract*: "It was at first thought that manifestations so distinct under slight magnification would yield very definite appearances under the microscope; but, on the contrary, much difficulty has been experienced in deciding the nature of the changes which have given rise to this phenomenon."

He suggests three possible explanations for the appearances:

(1) Masses of mononuclear leucocytes in the substance of the retina, surrounding a retinal vessel.

(2) Free collection of mononuclear cells on the surface of the retina, or—

(3) Degenerative changes in the retina.

In wounded eyes which were examined pathologically during the war I came across several which showed minute white spots on the retina, and had the opportunity of investigating some of these both macroscopically and microscopically. In one case especially a fairly complete examination was made:

Lieutenant M—, a Portuguese officer, was wounded in both eyes by the bursting of a bomb; there was penetra-

tion of both globes by pieces of metal. In the right a small piece of metal could be seen in the anterior chamber, lying on the iris up and out quite close to the angle, but there was no wound of the lens. In the left there was a wound of both the cornea and lens, and by the time he was seen at Boulogne, soft lenticular matter was projecting forwards from the centre of the pupil to the back of the cornea. In each eye there was a negative response to the large magnet.

The right eye was operated on: a peripheral incision was made with a narrow glaucoma knife, and the small piece of metal was extracted with forceps. The eye made a good recovery, with perfect vision.

In the left eye no foreign body was visible, and the eye being irritable, the soft lens matter was washed out by means of a curette evacuation, largely with the hope that if a foreign body were present in the lens, it might be washed out too. The eye, however, did not quiet down, and was still very red after ten days. By that time there was faulty projection, suggesting detachment of the retina, and it was deemed safer to remove the eye, for fear of sympathetic ophthalmitis being set up in the right eye, which was rapidly quieting down.

After removal the eye was fixed in formalin, frozen and divided. On examination a large synechia of lens matter was seen passing from the body of the lens to the scar in the centre of the cornea. The vitreous was infiltrated and shrunken to about one-third of its normal size, leaving a space between the hyaloid and the retina, which was occupied by a clear fluid (see Pl. V, fig. 2).

No foreign body was found, and neither the retina nor choroid were detached as had been suspected.

Dotted over the retina were very numerous small white masses, which varied in size from a pin-point to a quarter of a millimetre in diameter. They had no regular distribution, nor had their site any special relation to the retinal vessels, whether artery or vein (see Pl. VI, fig. 3).

Photographs were taken of the half eye showing the

PLATE V.

Illustrates Sir William Lister's paper on Punctate Deposits on the Retina (p. 275).

Fig. 1.—A case of penetrating injury followed by septic irido-cyclitis. The track of the foreign body can be seen through the cornea and the lens. There is very little shrinking and detachment of the vitreous, the greater part of which is infiltrated with flocculent masses of round cells, while on the right side there is a more homogeneous suppurative mass opposite the pars ciliaris retinæ. Dots of exudate of the same nature, though smaller, can also be made out in the anterior chamber, which would be recognised clinically as keratitis punctata. This is a case in which one would expect to find punctate deposits on the retina if the vitreous had become detached.

Fig. 2.—A case of penetrating wound of cornea and lens. A large synechia of lens-matter passes from behind the lens to the corneal scar. The vitreous is shrunken to less than half its normal size, and is slightly infiltrated with exudate in streaks and dots. Scattered over the retina are a large number of small white spots, together with some faint streaky lines of lymph.

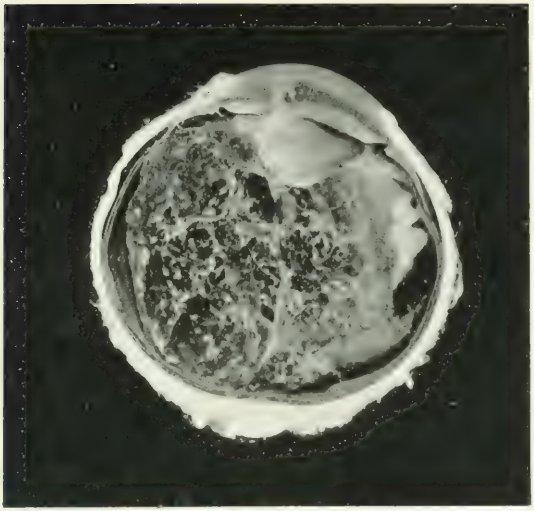


Fig. 1.

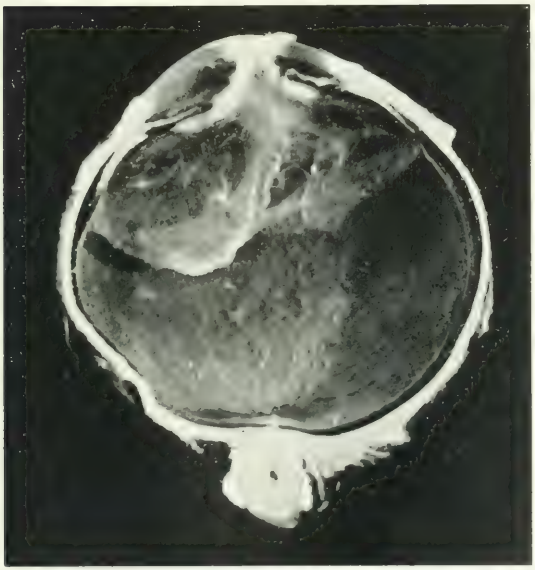


Fig. 2.

Adlard & Son & West, Bartholomew Close.

PLATE VI.

Illustrates Sir William Lister's paper on Punctate Deposits on the Retina (p. 275).

Fig. 3.—A portion of the retina from specimen shown in fig. 2 photographed on the flat under water. The white deposits are seen on the surface; they vary considerably in size, they have a rugose surface, and their distribution has no relation to that of the retinal vessels which are seen coursing in the substance of this membrane.

Fig. 4.—Another case of punctate deposits on the retina photographed as in fig. 3, in which there was a much larger mass lying in the region of the ora serrata; around it are seen numerous other smaller spots resembling those seen in fig. 3.

(The minute glistening dots in figs. 3 and 4 are caused by the deposition of fine grit from the water in which the specimens were examined.)

Fig. 3.

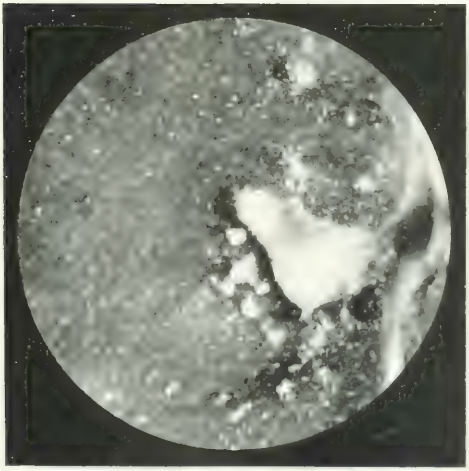


Fig. 4.

PLATE VII.

Illustrates Sir William Lister's paper on Punctate Deposits on the Retina (p. 275).

Fig. 5.—Section through one of the punctate deposits from the specimen shown in fig. 2. The deposit is seen to consist of mono- and polymorphonuclear cells held together with a small amount of fibrin. The mass rests on retina, which is apparently unaffected.

Fig. 6.—Section from same specimen showing a deposit on the top of an artery, the walls of which do not show any infiltration with round-cells.

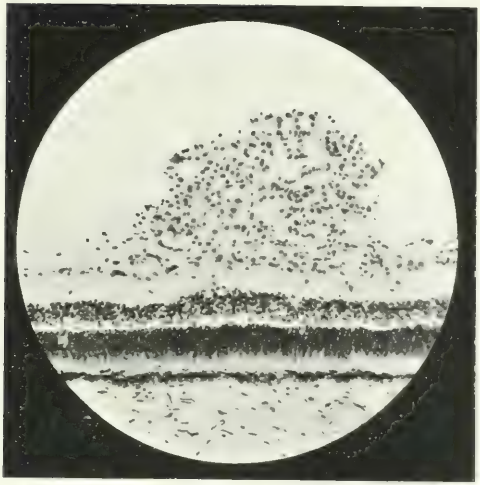


Fig. 5.

Fig. 6.

Adlard & Son & West Newman, Lith.

PLATE VIII.

Illustrates Sir William Lister's paper on Punctate Deposits on the Retina (p. 275).

Fig. 7.—Section from the same specimen through a retinal vein showing definite round-celled infiltration of its walls. Within the lumen of the vein a faintly-stained fibrinous clot could be made out.

Fig. 8.—Another section through a retinal vein in the same retina, which shows not only infiltration of its walls, but extension of the cellular invasion into a thrombus in the lumen of the vein.

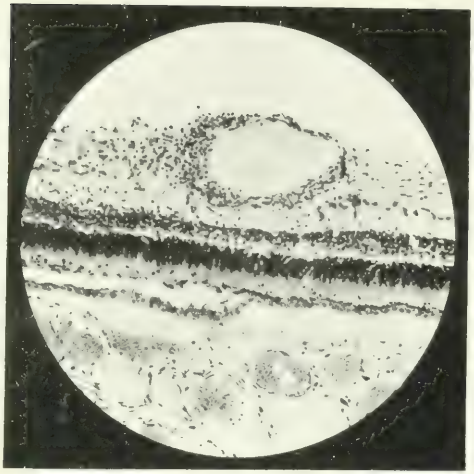


Fig. 7.

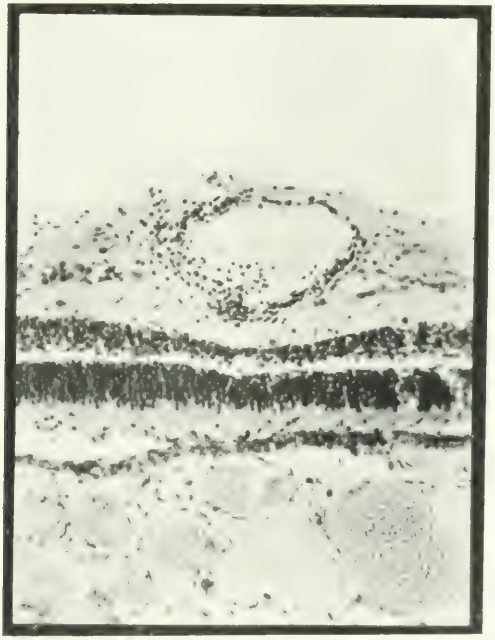


Fig. 8.

distribution of the spots, and enlarged stereoscopic pictures were also made which demonstrated them to be small white masses resting on the surface of the retina like minute anemones or mimosa flowers.

Sections were made of the retina and choroid passing through the spots. Under the microscope the small white masses were found to consist of groups of (mononuclear and polymorphonuclear) leucocytes bound together with a small amount of fibrin exactly resembling spots of keratitis punctata (see Pl. VII, fig. 5), and though attached to the retina the retinal layers immediately beneath were in no way altered. One was therefore driven to the conclusion that they had settled on the retina just in the same way that punctate deposits settle on the endothelium of the cornea, and that they were not derived from the retina any more than spots of K.P. are derived from the cornea.

Comparing this case with others, we found considerable variations of the size of the spots; thus in one case, also of a penetrating injury, a large mass of exudate some 2 to 3 mm. in diameter was found close to the ora serrata with the more usual small spots grouped round (Pl. VI, fig. 4). In another—probably of the same nature but a more advanced case—lines of exudate were seen on the surface of the retina.

Retinal veins.—Though we found the retina immediately beneath the spots was not altered, yet in neighbouring parts some of the retinal veins showed very definite round-celled infiltration of their walls (Pl. VIII, fig. 7), a condition which has also been noted by Col. Elliot, and not only was the wall infiltrated, but thrombosis was taking place, and round-celled infiltration was extending into the thrombus from the walls (Pl. VIII, fig. 8). In no instance did we find any infiltration of the arterial walls (see Pl. VII, fig. 6).

Source and significance.—We have now to consider the source of these spots and their significance. The fact that the retina on which they are resting shows no

alteration in structure is sufficient evidence that they are not derived from the retina—and if they are not derived from the retina they must come from the vitreous cavity and be formed either in the vitreous itself or on the surface of the ciliary body. Examination of the ciliary body shows no masses of cells adherent to its surface, and therefore it seems certain that these small groups must be formed in the vitreous. In the eyes in which deposits were found, both Col. Elliot's and my own, there was septic cyclitis with cellular infiltration of the vitreous. We know that by positive chemiotaxis leucocytes will collect round infected or dead cells, or groups of bacteria. Dead or infected cells, whether derived from the vitreous tissue or the surface of the ciliary body, or masses of organisms floating free in the vitreous, would become centres round which leucocytes would collect, and such masses as have been described could thus be formed. Such a view is corroborated by the fact that flocculent masses of cells were found in the vitreous in these cases.

Vitreous.—In all the cases in which punctate deposits were found on the retina the vitreous showed chronic infiltration, but they were never found in cases of acute panophthalmitis. It was often purulent in places, but for the most part showed an uneven streaky or dotted infiltration, sometimes with definite flocculent masses. Moreover, whatever the actual consistence of the vitreous it was *always shrunken and detached* more or less from the retina —that is to say, there was a space between the retina and the shrunken vitreous which was filled with apparently clear fluid. It would indeed seem probable that the existence of this zone of fluid is a necessary factor for the recognition or even the determination of this condition of punctate deposits on the retina. When the vitreous is in contact with the retina any groups of cells in the vitreous which were resting on the retina would not be distinguished from other groups in the vitreous. But when the vitreous is shrunken, the hyaloid (if such a membrane really exists) degenerated and broken up, and there is a zone of fluid

between the vitreous and the retina, then groups of cells formed in the vitreous could float off in this limpid fluid, be sown on the surface of the retina, and become visible as punctate deposits, just as in other cases similar masses come forward and appear in the anterior chamber (see Pl. V, fig. 1).

Col. Elliot suggests that these spots might be detected with the ophthalmoscope, but if the above views are correct this would be impossible, for there would always be opaque infiltrated vitreous which would prevent ophthalmoscopic observation.

That Col. Elliot had some difficulty in determining what microscopic change accounted for the macroscopic appearance of the white masses may be easily explained by the very loose adhesion of the spots to the surface of the retina. In several cases spots were at first detected and noted, but at a subsequent examination they had disappeared—there is little doubt that they had become washed off from the retina by the current of formalin solution when lifting out and replacing the specimens from their bottles.

As to the significance of these deposits on the retina, I think that one must consider them to be one of the manifestations of intra-ocular sepsis of a somewhat chronic nature and associated with contraction of the vitreous.

We have yet to consider whether there is any connection between these spots and the inflammation of the retinal veins, or whether we must look upon the latter as a quite separate manifestation of the septic condition.

Peri-vascular inflammation suggests the presence of some toxic irritant in the course of the peri-vascular lymphatics. Now it is known that the peri-vascular lymphatics in the retina are much more marked along the veins than along the arteries, so that it would be expected that if a toxic agent exists in the retina it would be drawn, and cause inflammation, along the course of the veins rather than along the arteries, in the same way that when there is free pigment in the retina, as in retinitis

pigmentosa, the pigment becomes deposited along the course of the veins and not along the arteries, as I believe Mr. Nettleship was the first to point out.

If the source of the spots given above is correct they are probably toxic. Since all the specimens were fixed in formalin before the condition was discovered, no opportunity arose of making cultures from them; and whether they form the supply of toxin which causes the perivascular inflammation and the septic thrombosis of the retinal veins or whether this is derived from elsewhere is at present uncertain. If these spots were responsible for the toxin it might be expected that there would be, at any rate in most instances, inflammation of the retina right up to where the spot is resting. None of our sections show this, though one of Col. Elliot's did. The matter wants further elucidation.

One interesting point in the first case recorded was that the projection was defective, yet there was no detachment of the retina. It is probable that the faulty projection was due to the septic degeneration of the retina, and the thrombosis of the retinal veins.

Summing up our present knowledge, it would seem probable that these punctate spots on the retina—

(1) Are one of the manifestations of a chronic septic irido-cyclitis which may go on to chronic panophthalmitis and septic thrombosis of the retinal veins.

(2) They are formed in the vitreous and not derived from the retina.

(3) They can only become distinguished or deposited on the retina when the vitreous is shrunken and separated from the retina by a zone of fluid.

(4) There is no sign of their being products of degeneration.

Mr. Treacher Collins thought the Society should congratulate Sir William Lister on having thrown fresh light on this peculiar condition. He (the speaker) had gone

through with Col. Elliot his specimens of eyes removed after couching, in which these retinal spots were present, and he did not think they had been previously described. They were a puzzle to Col. Elliot and himself. Sections were cut through the retina to find out what the spots were due to, but often nothing definite was discovered. He thought Sir William's suggestion that they might become washed off was a very likely one. He was glad to find Sir William adopting the suggestion that each of these dots represented a centre of chemiotaxis. That was the view advanced by Prof. Straub to explain similar dotted appearances in the vitreous humour, and also for the spots of keratitis punctata. Straub regarded each spot as containing a dead cell which became a centre of chemiotaxis.

2. *Some observations with the scotometer.*

By P. G. Doyne.

The chief use of scotometry in clinical ophthalmology is in the diagnosis of early cases of glaucoma.

Oftentimes scotomata occurring within the 20° circle—the arcuate scotoma of Bjerrum or the enlargement of the blind spot as first described by Seidel—are the earliest signs of the disease.

Recognising, then, the value of these signs, it was my object to see if any other conditions could produce similar scotometric appearances and so confuse the issue.

In this connection I have taken a large number of observations with the scotometer of cases of myopia and a smaller number of observations of cases of tobacco amblyopia.

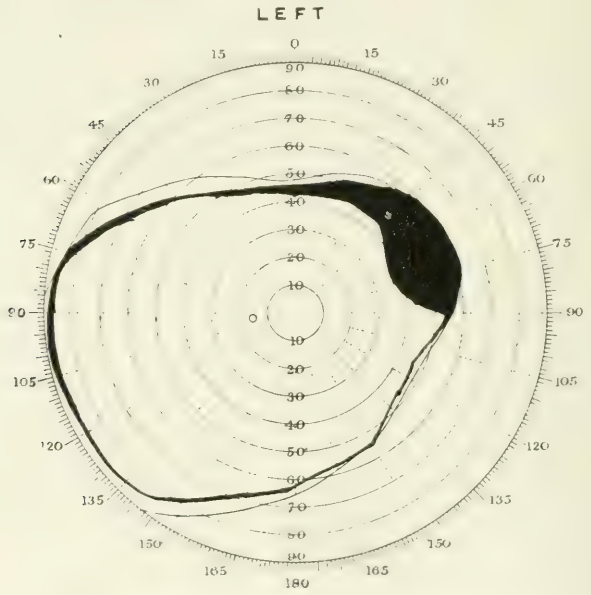
Most of my records have been taken in the Library at Moorfields. This room is lighted by a window facing north, the glass of which is frosted, so that the illumination from day to day was reasonably constant.

I have for the most part used the scotometer devised

by Col. Elliot, though latterly I have been employing Mr. Bishop Harman's instrument. All the records shown have been taken by the former method.

I consider the Bjerrum screen used at a working distance of 1 m. with a 2 mm. test-object to be the final arbiter in all cases. But I consider the Elliot scotometer is a very useful clinical instrument.

FIG. 41.



B. C—, January 31st, 1921. 5 mm. white square.

It has two great advantages:

(1) The test-object alone is presented to the patient. There is no holder, which can never be entirely fused with the background and which may distract the attention of the patient in his arduous task.

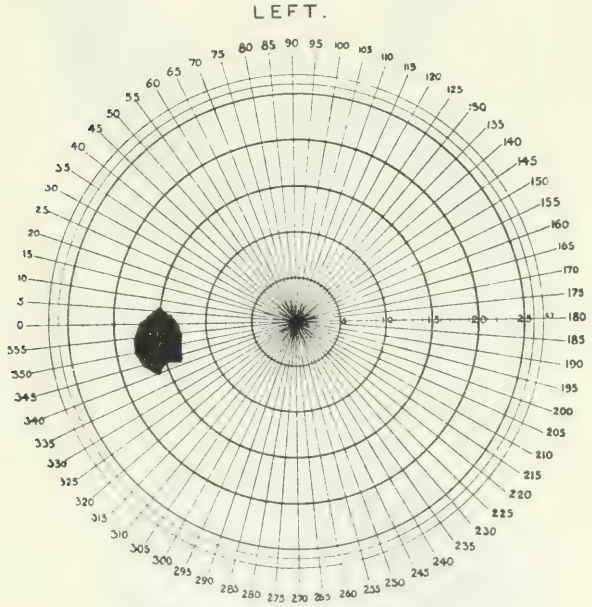
(2) The test-object is moved mechanically, and so it is possible to be certain that no area in the field is unexplored.

There are, of course, objections to this mechanical

moving of the test-object, and it is liable to cause abnormalities in the scotoma which is recorded by it. For instance, I have never been able to confirm by the Bjerrum screen those jagged edges to the scotoma which are so readily produced by the Elliot.

But the matter of real importance is to find the scotoma, if present, with rapidity and accuracy. Details

FIG. 42.



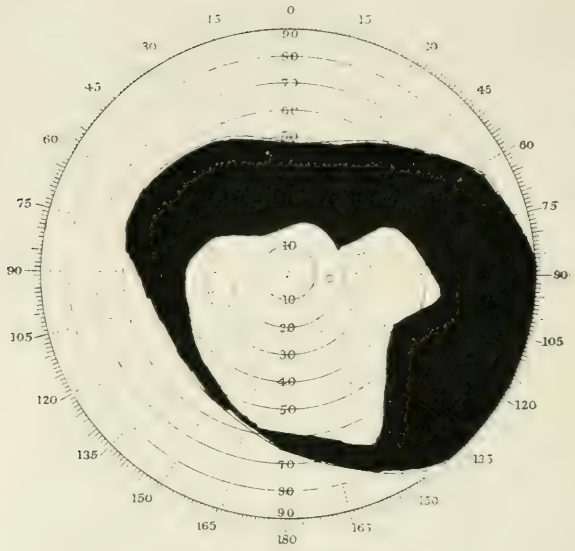
B. C —, January 31st, 1921.

of its shape are of less importance and can be checked by other methods.

The first series of observations are of cases of glaucoma, and demonstrate the various scotometric and perimetric appearances which may be met with.

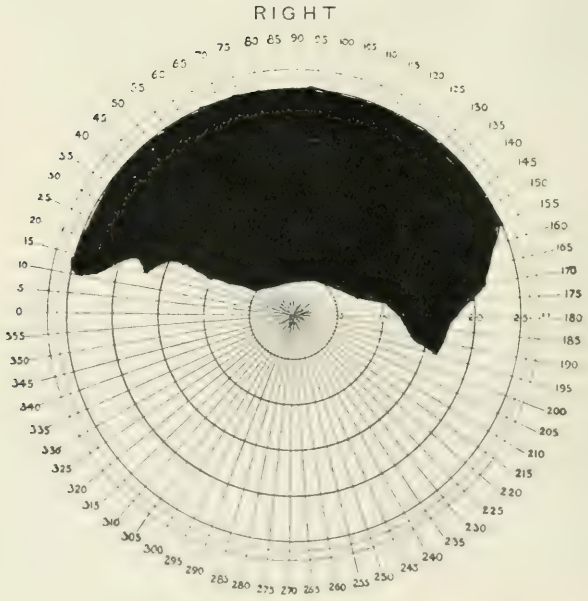
1. (Figs. 41 and 42.) "Marked nasal step with no central scotomata or enlargement of the blind spot L.E."

FIG. 43.



A. B—, July 30th, 1920.

FIG. 44.



A. B—, July 30th, 1920.

The R.E. had been blind for many years. The L.E. showed cupping of the disc with raised tension.

2. (Figs. 43 and 44.) "Loss of upper field reaching almost to fixation in the R.E."

In this case the lower edge of the disc was deeply and sharply cupped, whereas the upper edge showed a more gradual slope. The nerve-fibres, therefore, flowing over

FIG. 45.

Mrs. O—. October 7th, 1920.

the lower disc margin are those which are most damaged. This is what would be expected from the ophthalmoscopic picture.

The patient's L.E. had been trephined some years previously.

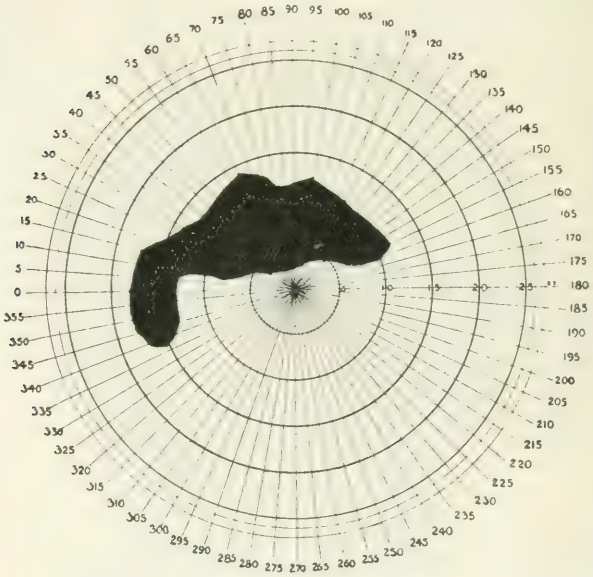
3. (Figs. 45 and 46.) In the R.E. the field is reduced to the 10° circle. This patient had a sudden acute attack of glaucoma in the R.E., with vomiting.

An iridectomy was performed, and while still an in-

patient the L.E. was examined and a typical Bjerrum scotoma was found, together with slight contraction of the nasal field and slight cupping of the disc. This eye was then trephined.

This actual record was taken some six months after the trephining, and shows a very slight reduction in the size of the scotoma as compared with the previous record.

Fig. 46.



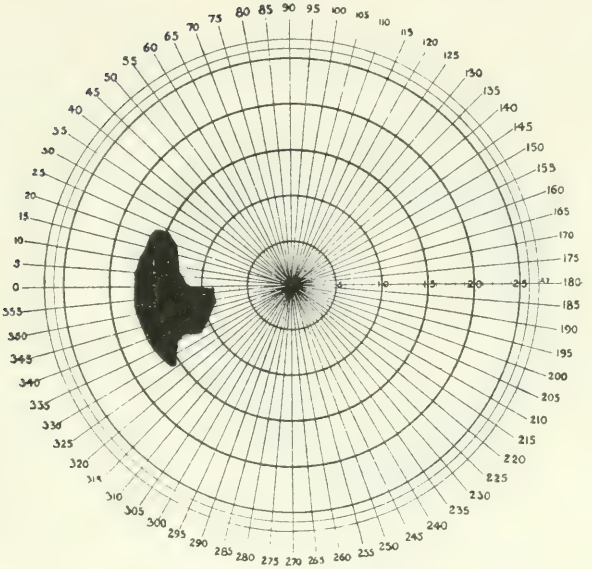
Mrs. O , October 7th, 1920.

The patient had had no symptoms previous to the acute attack in the R.E.

4. (Figs. 47 and 48.) "Enlargement of the blind spot of the L.E. After trephining some shrinkage of the blind spot, the previous enlargement being replaced by a relative area."

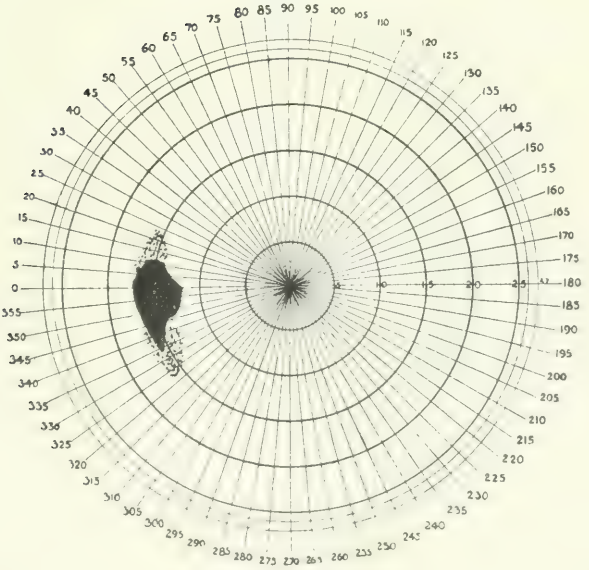
This patient had no symptoms, but suddenly discovered that his R.E. was blind. On examination the right disc was found to be deeply cupped and atrophic. The left

FIG. 47.



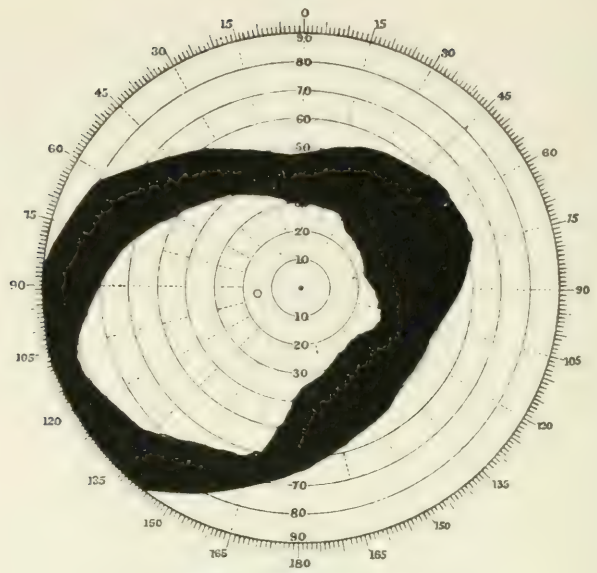
D. E—, January 29th, 1920.

FIG. 48.



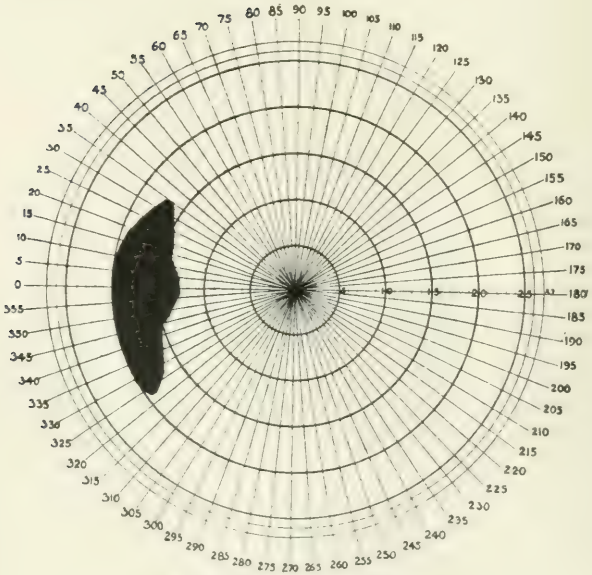
D. E—, April 7th, 1920.

Fig. 49.



M. M—. March 11th, 1920.

Fig. 50.



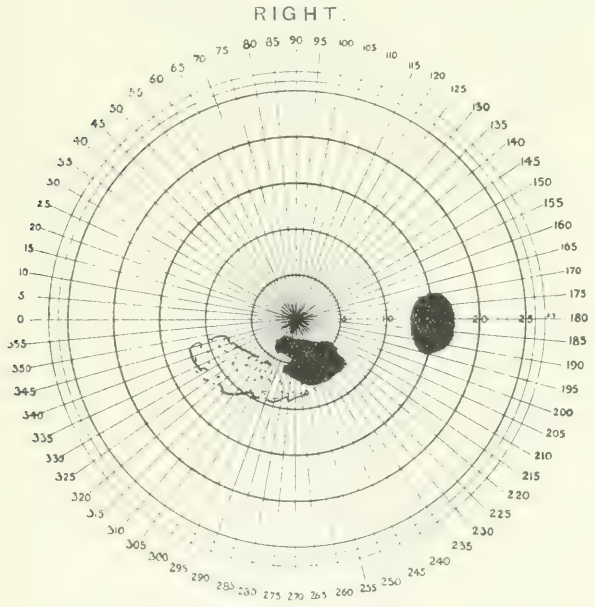
M. M—. March 11th, 1920.

disc showed slight cupping. The vision of the L.E. was $\frac{6}{6}$.

5. (Figs. 49 and 50.) "Contraction of nasal field with enlargement of blind spot."

6. (Figs. 51 and 52.) I wish particularly to draw your attention to this case. Here, for a considerable time, the scotometric signs were the only evidences of

Fig. 51.



W. H , May 31st, 1920.

glaucoma. This patient first came to Mr. Treacher Collins' out-patients at Moorfields on May 31st, 1920. He complained of occasional attacks of mistiness in each eye.

V.R. with — 1·5 D. sph. and — 3·5 cyl. axis vertical was $\frac{6}{36}$.

V.R. with — 1·5 D. sph. and + 2 cyl. axis vertical was $\frac{6}{18}$.

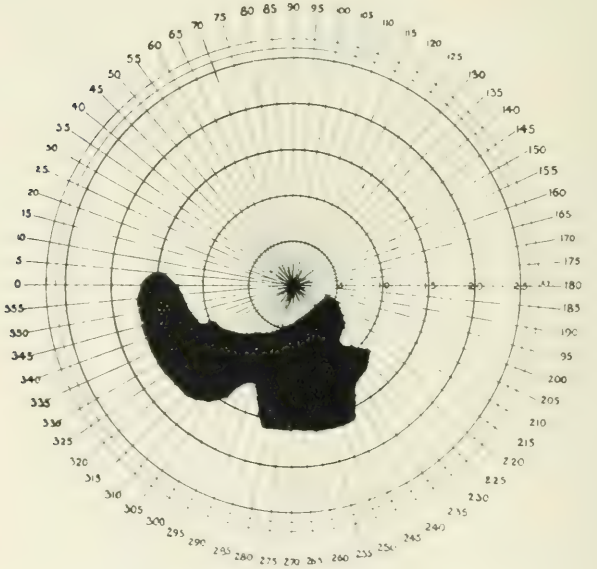
There was some early lens change in each eye, and very shallow excavation of each disc. The visual fields

were full and the Schiötz tonometer registered a tension of 25 mm. of Hg. in each eye.

With the scotometer, in the R.E. a small scotoma with a larger relative area was found situated on the 5° circle and on the 240° radius; and in the L.E. a well-marked Bjerrum scotoma below.

July 22nd, 1920 (Figs. 53 and 54): L.E., in addition

FIG. 52.



W. H—, May 31st, 1920.

to the Bjerrum scotoma below, a small scotoma on the 5° circle above has appeared.

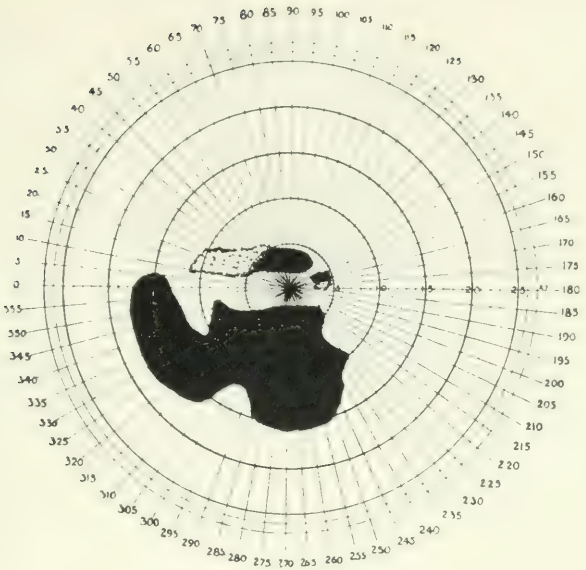
R.E., two small new scotomata on the 5° circle at 335° and 160° radii have appeared.

August 9th: L.E. trephined.

September 27th (Fig. 55): R.E., all scotomata larger and new scotoma between 5° and 10° circles at 10° radius.

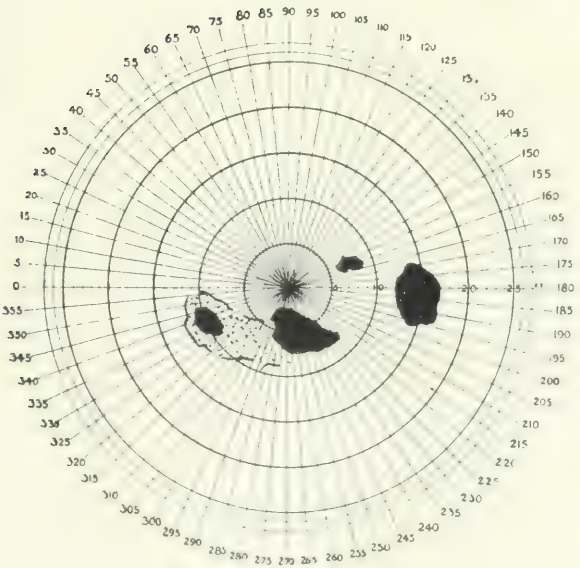
October 11th (Figs. 56 and 57): R.E., all scotomata

Fig. 53.



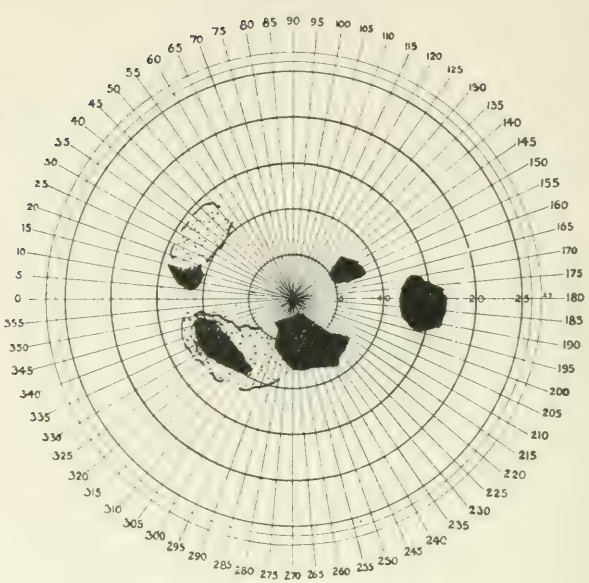
W. H—, July 22nd, 1920.

Fig. 54.



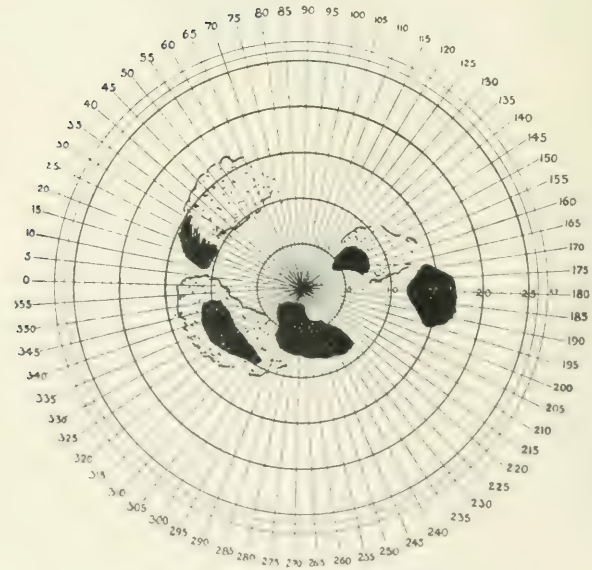
W. H—, July 22nd, 1920.

Fig. 55.



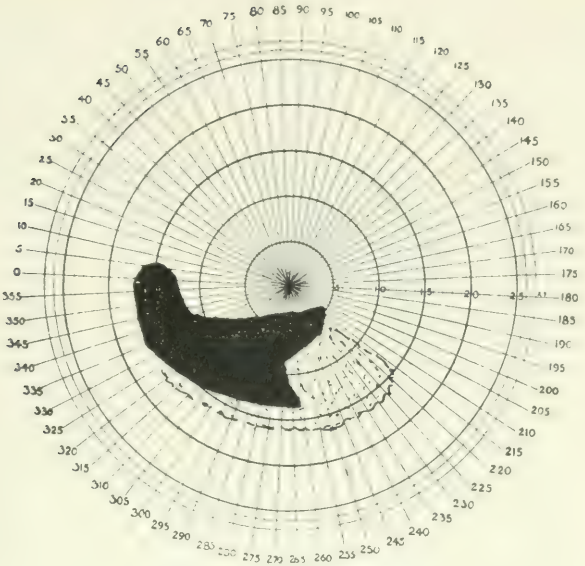
W. H—, September 27th, 1920.

Fig. 56.



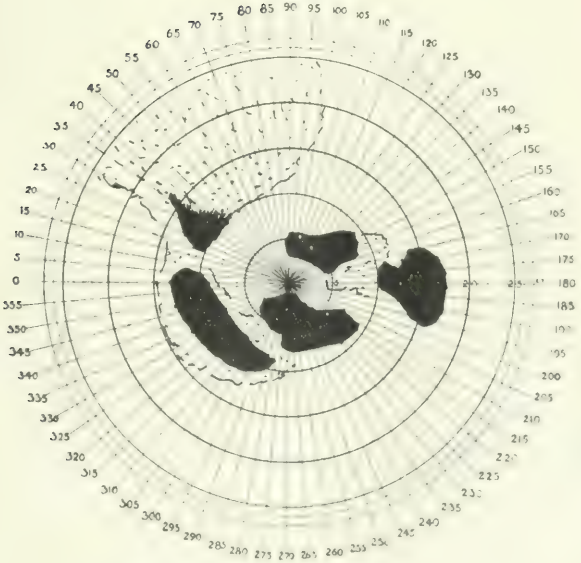
W. H—, October 11th, 1920.

Fig. 57.



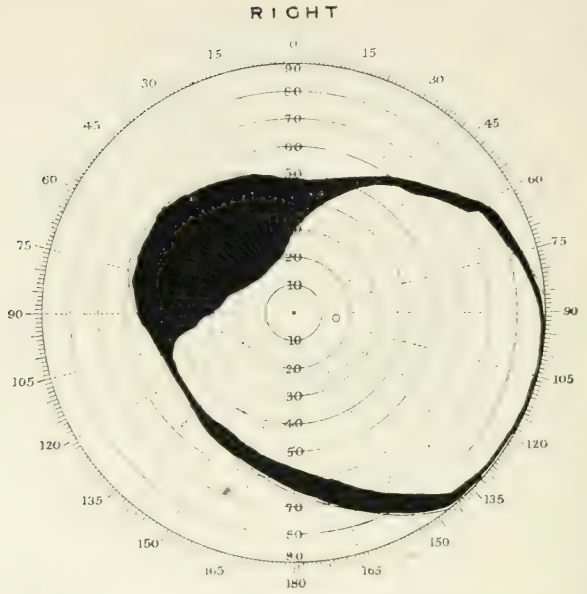
W. H—, October 11th, 1920.

Fig. 58.



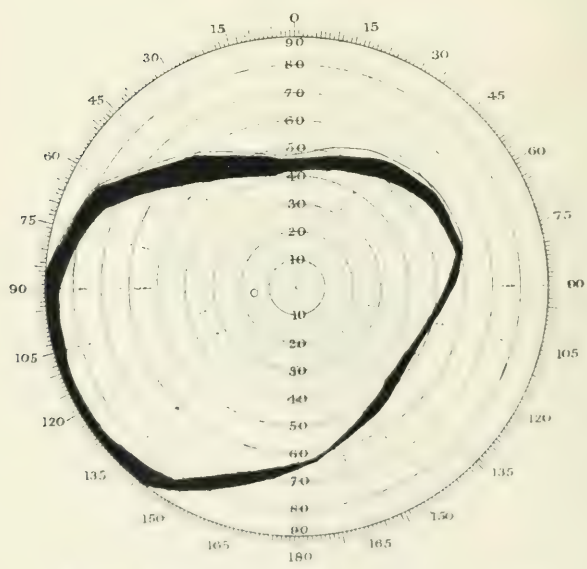
W. H—, November 22nd, 1920.

FIG. 59.



W. H—, November 22nd, 1920. 5 mm. white square.

FIG. 60.



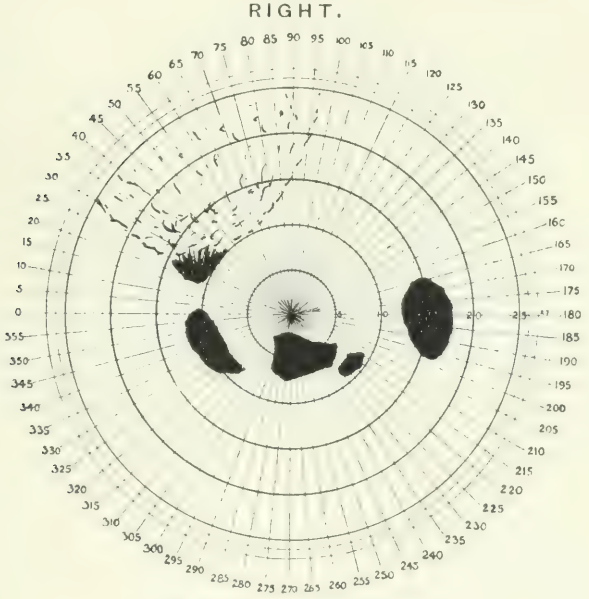
W. H—, November 22nd, 1920. 5 mm. white square.

bigger with satellite relative areas. Slight contraction of nasal peripheral field noticed.

L.E. contraction of scotoma below and complete disappearance of upper scotoma.

November 22nd (Figs. 58 and 59): R.E., all scotomata bigger. Blind spot enlargement towards scotoma on 5° circle, 160° radius. Marked loss of nasal field.

Fig. 61.



W. H - , January 3rd, 1921.

L.E. (Fig. 60): peripheral field full.

November 29th: R.E. trephined.

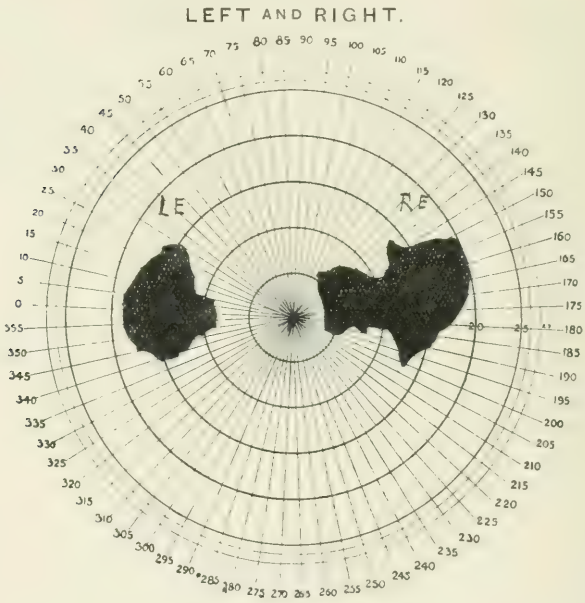
January 3rd, 1921 (Fig. 61) R.E., all scotomata smaller. Disappearance of scotoma on 5° circle, 160° radius. Blind spot normal.

This case illustrated well the occurrence of scotomatous islets along the track of the Bjerrum scotoma, which islets gradually enlarge as the disease progresses. It shows that the blind spot may remain at the same time

unaffected and affords an accurate method of following the progress of the disease.

Turning now to the series of myopic cases, I have taken a large number of observations of the blind spot and central zone in cases of myopia. In the vast majority no abnormal scotometric appearances were found.

FIG. 62.



A. M —, April 8th, 1920.

The records therefore which I show here represent the exception to the rule.

In all these cases in which abnormal appearances were found there was a marked degree of stretching and atrophy around the optic disc.

One fact very definitely impressed itself upon my mind, namely that it is not possible to estimate from the ophthalmoscopic picture what form of scotoma will be revealed by the scotometer.

The patients always wore their correcting glasses while the observations were being made.

1. (Fig. 62.) Both blind spots enlarged with extensions towards fixation, the latter most marked in the R.E.

This appearance is what would be expected from the ophthalmoscopic picture, as there were large temporal crescents, together with a ring of atrophy, around both

Fig. 63.

F. S—, March 25th, 1920.

discs. The crescent of the R.E. was 1½ P.D. (papilla diameter) in size and that of the L.E. ⅔.

Correcting lenses: R.E. — 9·0 D. sph. with — 4 cyl. axis 30°; L.E. — 11·0 D. sph. with — 6 cyl. axis 140°.

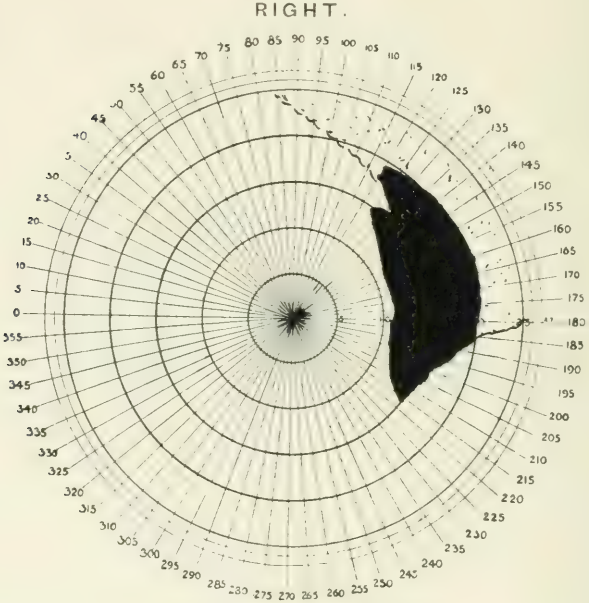
2. (Fig. 63.) R.E.: Scotoma extending along 15 circle and somewhat resembling a Bjerrum scotoma. L.E.: Irregular enlargement of blind spot. In the R.E. there was a temporal crescent, 1 P.D. in size, especially marked down, in and out, with some localised spots of atrophy

in continuation, and in the L.E. some atrophic spots around the disc margin.

Refraction: R.E. — 18 D.; L.E. — 16 D.

3. (Fig. 64.) R.E.: Extension of blind spot upwards and downwards with relative area up and out; some resemblance to Seidel's sign.

Fig. 64.



J. W—, March 29th, 1920.

With the ophthalmoscope no definite crescents, but atrophy surrounding disc, especially to nasal side.

Refraction: R.E. — 6·0 D. sph. with — 3 cyl. axis 130°.

4. (Fig. 65.) In the R.E. there was an inferior crescent, 1 P.D. in size, yet the blind-spot enlargement is below.

Refraction: R.E. — 8·0 D. sph.

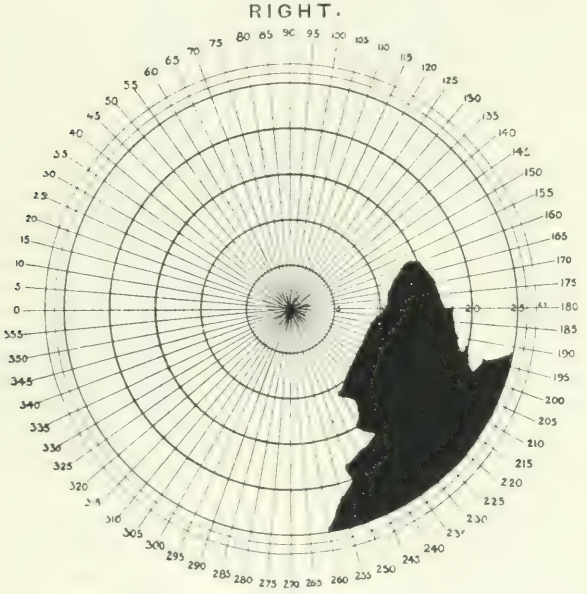
5. (Fig. 66.) Blind spot enlarged upwards and outwards to 25° circle and to 65° radius. Visual field not contracted.

Refraction: R.E. — 9 D. sph. with — 4 cyl. axis 45°.

With the exception of the first case all the cases have one feature in common, namely an enlargement in the blind spot of what corresponds to the nasal side of the disc.

Peter, in his book on perimetry, states that this enlargement, to a greater or less extent, is often met with in all

FIG. 65.



G. F—, August 3rd, 1920.

kinds of cases, and suggests as possible causes: 1) That there are fewer rods and cones in this area; (2) that there may be a bunching of nerve-fibres in this situation.

All the cases shown here were examined while wearing their correcting glasses—concave lenses of high degree. It seems possible that the acute angle at which the light, coming from the zone in question, would strike the glass might cause a large amount of the light to be reflected from the surface of the glass. Less light would then reach to the nasal side of the disc, where it is possible

that normally there was some diminution in the number of the rods and cones, and where in these cases there was evidence of stretching and atrophy of the coats of the eye. The retina to the temporal side of the macula, being in better condition, would not be affected to the same extent by any reduction in the light due to reflection from the surface of the spectacles.

FIG. 66.

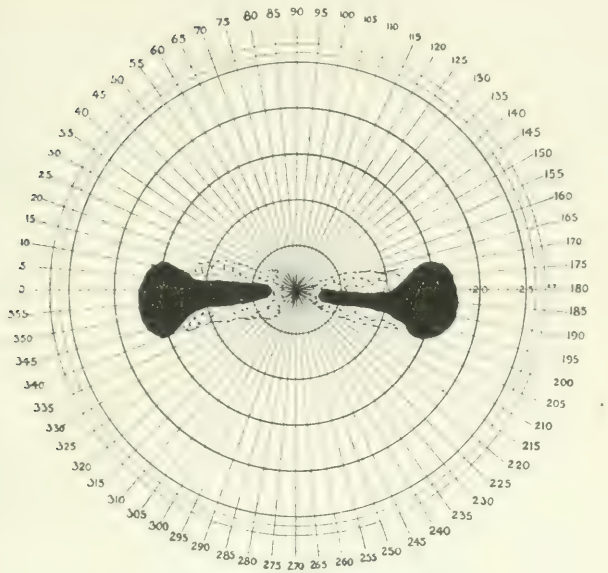
D. B—, March 4th, 1920.

The following cases of tobacco amblyopia were investigated in a similar manner to that employed in the cases of glaucoma and myopia, namely with the Elliot scotometer, using a 2 mm. test object at a working distance of 1 m.

1. (Fig. 67.) Scotoma to white in each eye extending from the blind spot to within the 5° circle with a small surrounding relative area.

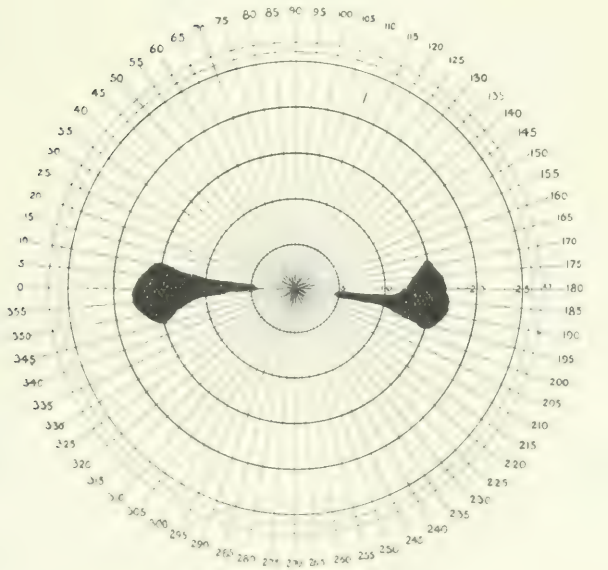
First seen November 8th, 1920. V.R. and L. less than

Fig. 67.



W. C[illegible], December 12th, 1920

Fig. 68.



W. C[illegible], January 13th, 1921.

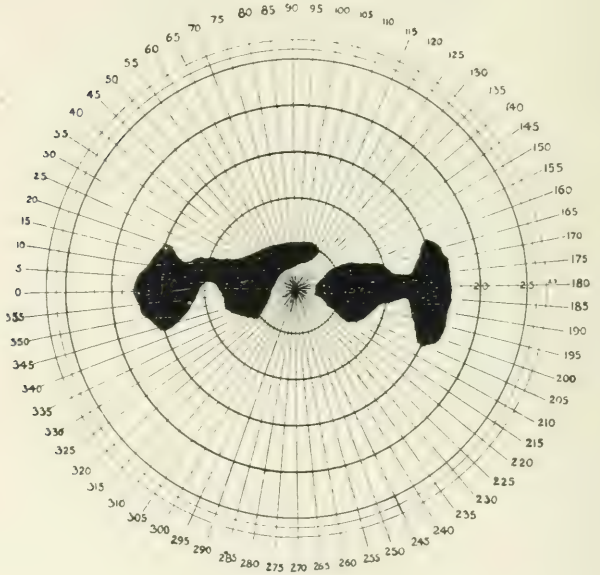
$\frac{6}{60}$; visual fields normal; central scotoma for red and green.

Patient has noticed his vision failing for the last four months. He states that he smokes $\frac{1}{2}$ oz. of shag a day.

Advised to stop tobacco and ordered strychnine mixture.

Fig. 69.

LEFT AND RIGHT.



H. B—, December 20th, 1920.

January 13th, 1921. (Fig. 68.) V.R. and L. $\frac{6}{24}$. Reduction in size of scotomata, which barely reach to 5° circle.

2. (Fig. 69.) Scotomata on 5° circle, joined by narrow band to blind spot.

December 20th, first seen; complains of difficulty in reading and defective vision for the last two months; smokes $\frac{3}{4}$ oz. a day. V.R. $\frac{6}{9}$; V.L. $\frac{6}{18}$.

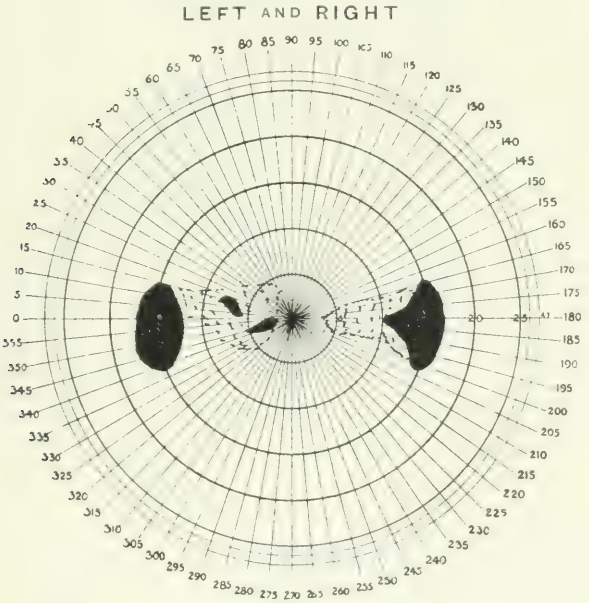
Central scotoma for red and green in both eyes; slight temporal pallor of left disc.

Advised to stop tobacco and ordered strychnine mixture.

January 10th, 1921. (Fig. 70.) The scotoma on the 5° circle is now represented in the L.E. by two small islets and a relative area towards the blind spot. In the R.E. no central scotomatous islets, but relative area between blind spot and 5° circle. V.R. $\frac{6}{6}$; V.L. $\frac{6}{12}$.

3. (Fig. 71.) In each eye a scotoma extends from the blind spot to inside the 5° circle.

Fig. 70.



H. B—, January 10th, 1921.

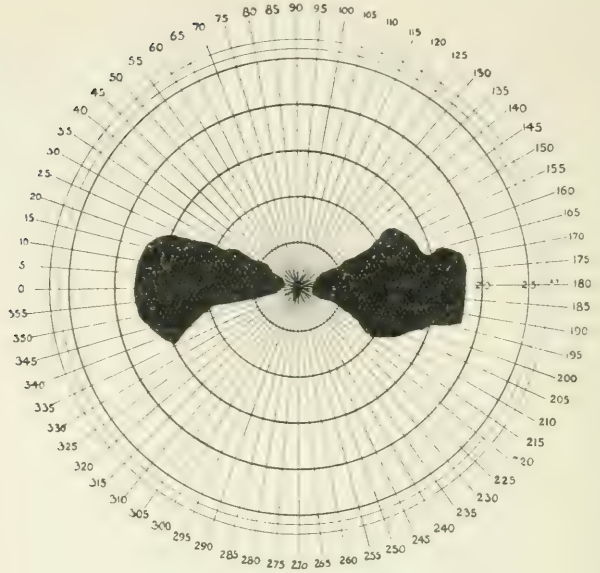
First seen January 17th, 1921. Complains of a mist in front of the eyes, which he has noticed since the summer. He states that he smokes $\frac{3}{4}$ oz. of twist a day.

V.R. and L. $\frac{6}{36}$; refraction normal; central scotoma for red and green.

Advised to stop tobacco and ordered strychnine mixture.

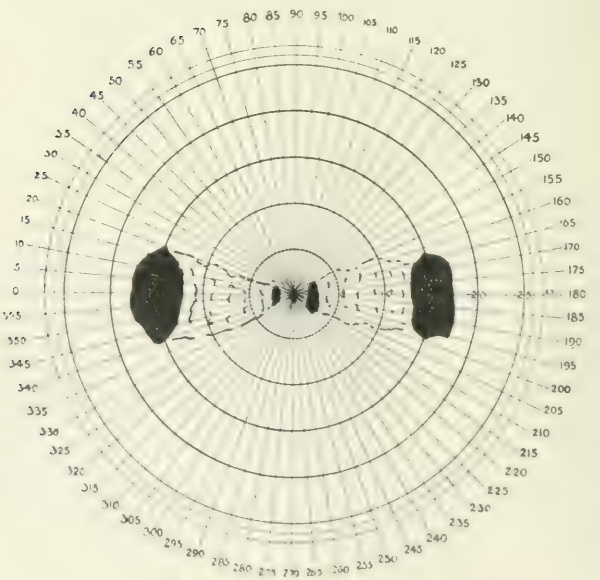
February 14th: V.R. and L. $\frac{6}{18}$. Small scotomatous islets inside 5° circle and relative area between them and the blind spots (Fig. 72).

FIG. 71.



W. N—, January 17th, 1921.

FIG. 72.

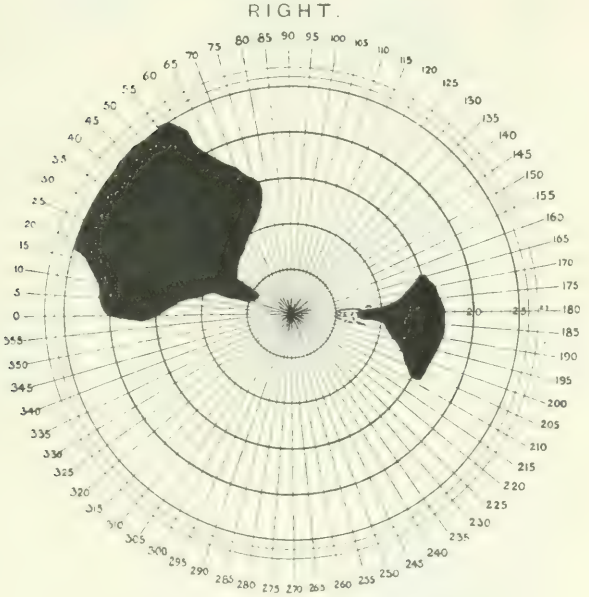


W. N—, February 14th, 1921.

4. (Figs. 73 and 74.) November 18th, 1920. Patient complains of dimness of vision, which has gradually increased during the last nine months. He smokes $\frac{1}{2}$ oz. of shag a day.

V R. and L. $\frac{6}{18}$. The chart shows an extension of the

FIG. 73.



R. J—, November 18th, 1920.

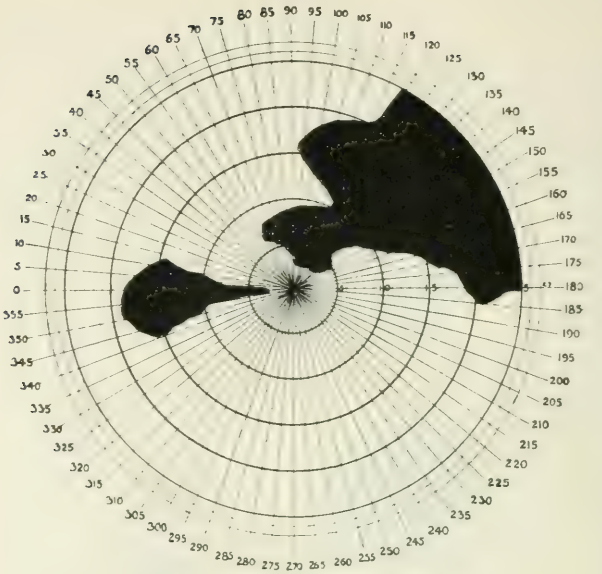
blind spot towards fixation in each eye and also a large scotoma up and out.

On examination this patient was found to be suffering from tabes, which diagnosis was confirmed by Dr. Gordon Holmes.

However it was thought there was a tobacco element in the case, and he was advised to stop all smoking.

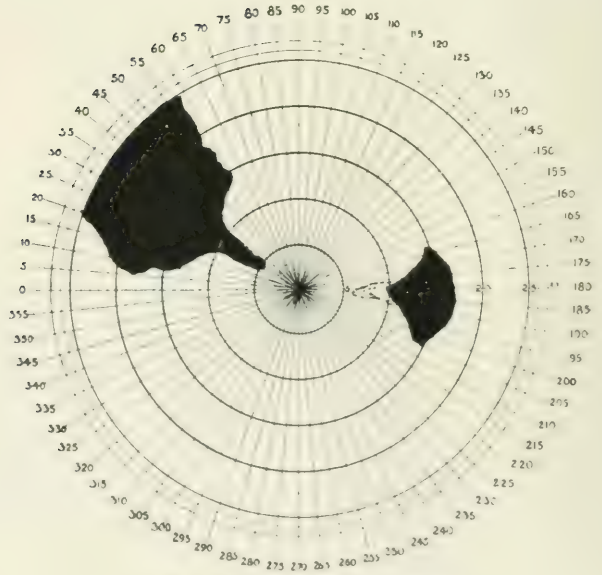
December 16th, 1920. (Figs. 75 and 76.) Definite decrease of blind spot enlargement, while the other scotomata are unaltered.

FIG. 74.



R. J—, November 18th, 1920.

FIG. 75.

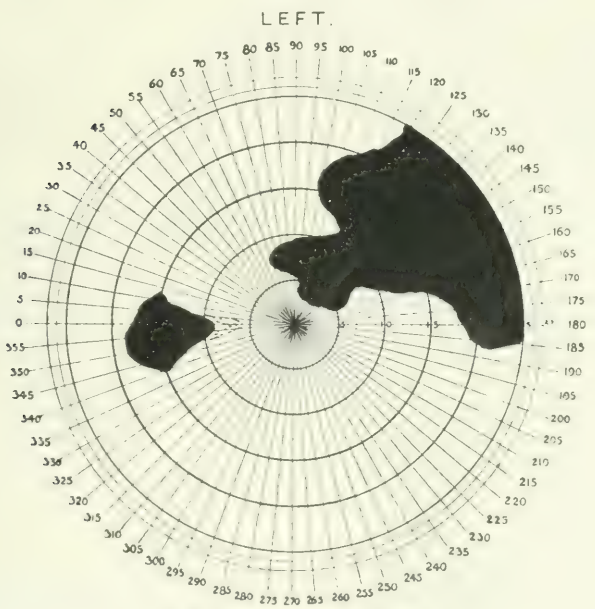


R. J—, December 16th, 1920.

It would appear, therefore, that the enlargement of the blind spot towards fixation was due to tobacco poisoning.

From a general survey of these cases it would appear that, as an aid to the early diagnosis of glaucoma, most reliance should be placed upon the discovery of scotomata situated along the 5, 10 and 15° circles surrounding the fixation point, and that enlargement of the blind spot,

FIG. 76.



R. J—. December 16th, 1920.

though often obtained, is not so valuable for the purpose of diagnosis, inasmuch as other conditions may produce similar enlargements.

In conclusion I would wish to express my thanks to Mr. Treacher Collins, from whose out-patients at Moorfields these cases were selected, and who encouraged me to examine them.

The PRESIDENT (Mr. J. HERBERT FISHER) said the Society

thanked Mr. Doyne for his practical demonstration and his explanation in regard to the blind spot. One was faced with the fact that the poorer classes, from which the majority of these cases came, were smokers of shag tobacco; but he had seen similar cases among wealthier people from constantly smoking Trichinopoly cigars.

Mr. Treacher Collins said he thought Mr. Doyne's observations on tobacco amblyopia were very interesting. Some of these cases were difficult to diagnose, and anything which assisted in the diagnosis would be valuable. The fact that the blind spot extended outwards towards the fixation spot in these cases was a symptom of the disease which had not previously been described.

Mr. Roper said that, in his experience, the condition always arose from smoking shag tobacco. There was but little twist tobacco smoked in the agricultural district from which he hailed. He recalled one case of tobacco poisoning in a well-to-do man, who smoked twenty-two Trichinopoly cigars per day. He was a retired Indian Army officer. He got all right on leaving off the smoking.

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3. *Some points in the anatomy of the orbit.*

By Prof. F. G. Parsons.

Prof. Parsons said it had been a great pleasure to him to get together and show what specimens he had bearing on ophthalmological subjects. They would notice that there were some partial sections and partial dissections of the orbit, and one thing with which he was very much struck—though probably they knew all about it—was the position of the eyeball in the orbit—the height at which it was situated. If he had been asked to draw an eyeball in its proper position in an orbit he would have put it about the middle, but instead of that it was quite close up to the upper margin.

Another thing shown by the same specimen was that

the optic nerve showed a curve. It was not a straight nerve, but quite S-shaped when seen from the other side, so that he presumed that there might be a good deal of effusion of blood into the posterior part of the orbit or a new growth, without any serious effect being produced on the optic nerve, there being plenty of room in it for stretching. Another section showed the whole course of the optic nerve from above, and he did not know that there was anything very striking about it except that it gave a fair idea of the whole course of the nerve, and also the relation of the various nerves in the cavernous sinus making their way to the orbit. It also showed that the sixth nerve did not lie anywhere near the dorsum sellæ. They had been in the habit ever since he had been a student of describing the groove on the side of the dorsum sellæ as made by the sixth nerve, but it was not. The groove in question was made by the inferior petrosal sinus.

Another specimen showed the lacrymal gland, which was described in many text-books as consisting of two parts—an upper orbital part and a lower palpebral part. The specimen shown indicated what he thought occurred in almost every case. The gland was not divided into two parts but deeply grooved by the levator palpebræ superioris tendon, which went right into the gland and made a deep groove in the anterior part, so that the division of the gland into two parts only occurred quite in the anterior portion.

Another set of specimens of a series of orbits showed points which he thought were really new. The very curious and rapid growth in the orbit in the early months of life after birth was extremely interesting. At birth the orbit was extremely low; in three months it had increased immensely and was comparatively deep; in a child of five years of age it was deeper still, nearly as wide downwards as from side to side, and a few months later the characteristics of the adult orbit were noticeable. The very sudden change in the shape of the orbit after

birth was a very difficult problem to account for. They knew, of course, that the face increased in size very rapidly after birth and that that had always been attributed to the teeth. There was, however, so little change in the teeth part of the jaws that it was almost inconceivable that the teeth could have any effect on the rapid growth of the orbit. Another possibility was that the deepening of the orbit from above downwards was correlated with the change in the air-passages. It was rather going into a question apart from their particular science, but he might say that it was very well known that those who lived in hot climates almost always had broad noses, whereas those who lived in cold climates had narrow noses, and that while the nose narrowed it deepened from above downwards, the presumption being, of course, that the colder climate necessitated more apparatus for warming the air by passing over the turbinal bones. In that process one got a narrowing of the nose, whilst, in order to get the same amount of air passing through, there was also a deepening of the nose. In the Nordic races and the races inhabiting cold climates, as well as in some of the races such as the Esquimaux, it was customary to see long faces and long and very narrow noses. The question was whether the deepening of the nose could account for the deepening of the orbit. Possibly it might, but the specimens did not bear that possibility out. It seemed to him that the growth of the orbit was the first change that occurred. The orbit grew very rapidly in the early months of life and the nose followed suit much later. The child at birth had the broad nose of the lower races of mankind, but by the time it had reached five years of age it had a deep, narrow nose. In any case the sudden change in the shape of the orbit was very striking, and the explanation, whatever it was, would be an interesting one to work out.

The PRESIDENT did not think anyone would be prepared to controvert the new facts which Prof. Parsons had

put so fully before them. It was certain that the orbits did change. Their thanks were due to Prof. Parsons for preparing the specimens and attending the discussion to deal further with them, especially in view of the fact that the Anatomical Society, of which Prof. Parsons was President, was holding a meeting simultaneously with their own.

4. *Congenital coloboma of disc, with high degree of hyperphoria.*

By G. Maxted.

Norah F—, æt. 25 years. Complains of constant headaches, mainly on vertex and occiput, to a less degree over her eyes, which ache when using them for close work. Vision, $\frac{6}{6}$ in each eye.

Correction of + 0·5 D. astigmatism in R.E. and 0·5 D. hypermetropia in L.E. makes no difference to her symptoms.

The whole of the right disc is involved in a congenital coloboma, the disc being about three times the size of the left one and very deeply cupped, the edge of the disc being in focus with + 3 D. sph., and the bottom of the cup being focussed with about − 5 D. sph.

There is a high degree of right hyperphoria, which is corrected by a prism of 7° base up before the left eye.

For the last twelve months she has worn constantly a prism of 2° base down over right eye, base up over left eye, but has got little relief from the glasses.

Mr. Maxted said that from the appearance of the disc one imagined that it was one of the rarer forms of congenital coloboma; the whole of the disc was affected and the retinal vessels could be seen entering and emerging near the upper border. He would like to have the opinion of members as to what was the proper treatment

for the hyperphoria, as her headaches were almost intolerable. The patient was a lady's maid, did very little needlework, and had been wearing prisms 2° base up one eye and base down the other, but that did not seem to have relieved her at all.

The case was one in which two congenital abnormalities were associated, namely, the coloboma of the disc and the hyperphoria.

Mr. A. S. Percival said that as the hyperphoria was 7 degrees apical angle he should certainly try correction with prisms, allowing the patient to stay in his waiting-room for about an hour in order to ascertain whether she could read comfortably with the prisms; if so, he would not hesitate to order them. The case in question did not really show a very high degree of prismatic correction—$3\frac{1}{2}$ degrees in each eye, one up and one down. After the patient had worn the prisms and provided she could wear them comfortably one might consider interference, but he felt almost certain that either lengthening the tendon or performing any other operation would be useless unless one found that the prisms relieved the symptoms. The advantage of the operation would be that the patient would not be bothered with prismatic spectacles and the troublesome reflection images they often entail.

5. *Pituitary tumour treated by decompression.*

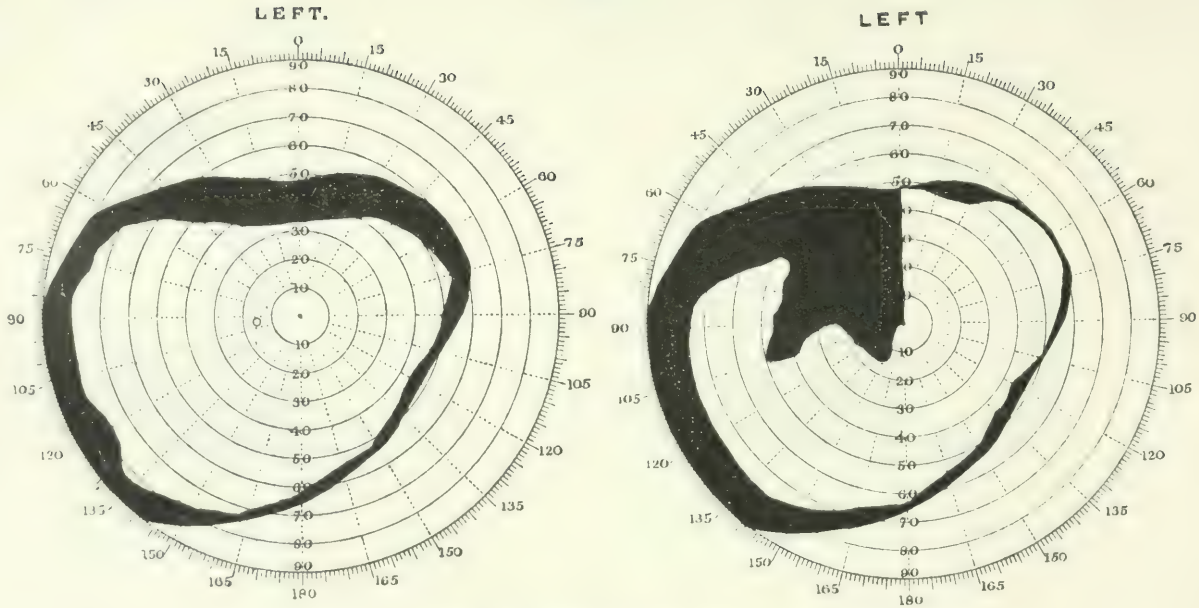
By Percy Sargent, C.M.G., D.S.O.

A. M—, æt. 21 years. Patient of Dr. Gordon Holmes.

Defect of vision three years. First noticed that he could not see things at his right side. For about twelve months has been blind in right eye.

Sleepy-looking effeminate boy; pale; bright flush on cheeks. Fine dry skin, thick layer of subcutaneous fat. No hair on face, axillæ bare. Increased sugar tolerance.

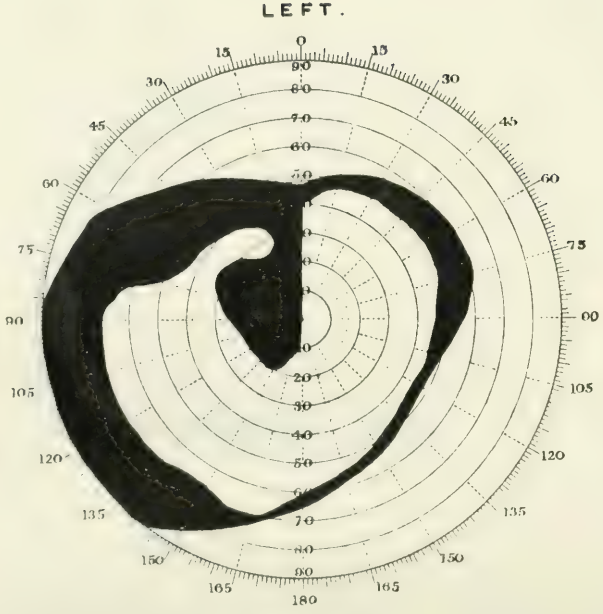
FIG. 77.



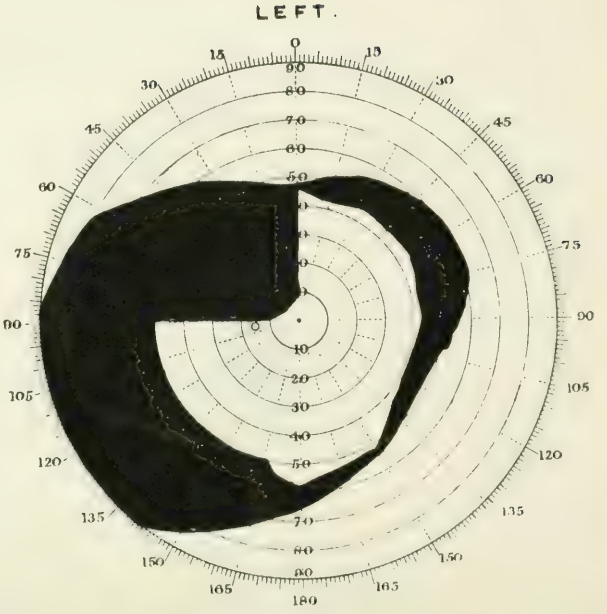
M - (Dr. Gordon Holmes' case).

February 22nd, 1913. White, 10 mm.^{2} May 27th, 1913.

FIG. 78.

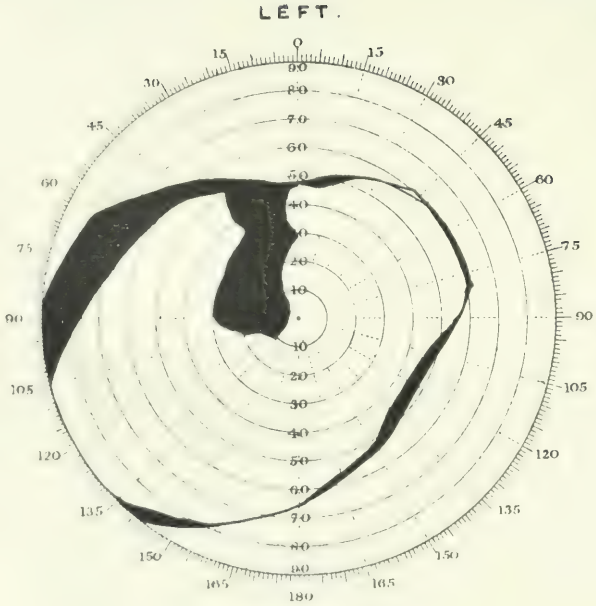


October 6th, 1913.

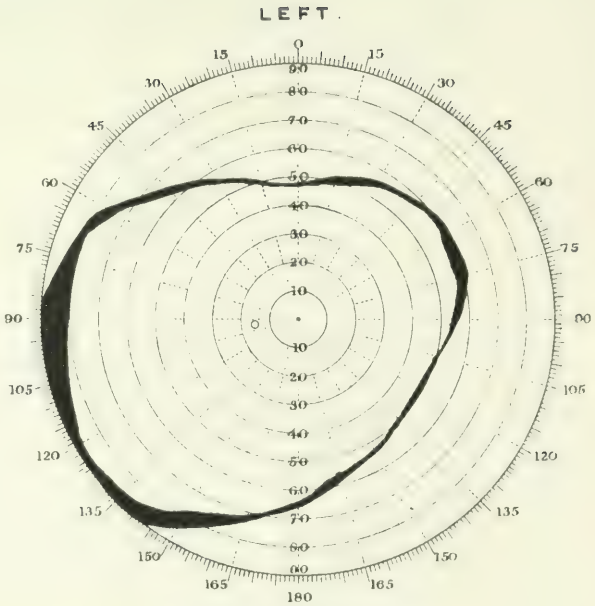


November 2nd, 1913.

FIG. 79.



November 14th, 1913.
(Twelve days after operation.)



February 14th, 1914.
(Three months after operation.)

Operation November 5th, 1913: Trans-sphenoidal sellar decompression.

November 18th: Left hospital perfectly well.

The PRESIDENT said that unfortunately Mr. Sargent was not able to be present and deal with his specimens, one of which was a supra-pituitary tumour, not of a very malignant character but of quite a slow growth and which presented all the symptoms of hypopituitarism. It was an extremely interesting case, because an X-ray picture had been taken on which a clear outline of a normal sella turcica was revealed, and it was really by the pressure of the supra-pituitary tumour upon the pituitary body that the functions of the pituitary body were interfered with. It was an important point in diagnosis to make out definitely whether the tumour was within the sella turcica or above it. Then Mr. Sargent had also shown a successful case of intra-nasal operation, in another case of hypophysis tumour, illustrated by charts which showed that a very satisfactory and rapid recovery of vision followed his operation.

6. *Epithelial cysts of the sclera.*

By CHARLES GOULDEN AND MAURICE H. WHITING.

(With Plate I, fig. 2, p. 139, and Plate IX, figs. 1 and 2.)

TUMOURS of the sclera are among the rarest conditions met with in ophthalmology, and very few cases have been published; fibroma, fibrosarcoma and osteoma have occurred in a few instances only.

Epithelial cysts, either congenital in origin, the result of some developmental error, or those due to an injury are the most common, and may be considered together. This type does not include congenital cysts of the sclera which occur in conjunction with defects of the other membranes of the eye, and which are not true cysts.

We have been able to find eleven cases of epithelial cyst of the sclera in the literature, two of which are stated to be congenital. The following is a *résumé* in order of their date of publication :

Lawrence.—"Small watery cyst in the sclerotica of a child ; successfully treated by cutting away the prominent portion of the cyst." A child ten years old had a semi-transparent firm oval swelling, as large as a small pea, on the sclerotica close to the margin of the cornea, where its existence had been noticed for some years. There was no change in the conjunctiva. It had been punctured; watery fluid escaped and the accumulation was soon renewed. Two or three gentlemen who had seen the case advised that no further proceeding should be resorted to. As the swelling already constituted a slight blemish, and was increasing in size, my recommendation of an operation was readily adopted. I punctured the cyst and then cut away its prominent portion with curved scissors. It was thin but tough, the sides being firm enough to retain the figure of the swelling after it had been opened. The interior was smooth, and a small round aperture was seen in the middle of the basis, apparently passing through the sclerotica. The surface exposed by the operation slowly healed without any unpleasant symptom and the blemish was completely removed. At the distance of two years from the operation the eye continued perfectly well.

Lawrence.—"Larger cyst of the sclerotica ; excision of its prominent portion." A gentleman, æt. about 30 years, of robust frame and full habit, had lost one eye by violent inflammation, which had caused extensive opacity of the cornea, with adhesion of the iris. A cyst formed in the sclerotica, and slowly acquired the size of an almond, not only increasing the deformity, but also causing irritation in the motions of the globe and lids. I removed the exterior portion of this bag, as in the last case, but I did not see the patient again.

Waldhauer.—Only a very short report is available, as

the original description is in a journal that is not in any library that is available.

The case was that of a boy, æt. 13 years. There was a large cyst extending from the reflection of the conjunctiva at either canthus to the edge of the cornea. It was opened with scissors; a clear fluid escaped; the anterior wall was fibrous, its posterior wall smooth. On applying pressure the cyst closed to an opening the size of a pin's head. Six months later the cyst had not recurred, and there was still a depression at its site. The author suggested that it was in origin a hydrops of the canal of Schlemm.

Colburn.—The case of a boy, æt. 15 years, who six months before the doctor saw him noticed a small cyst at the inner canthus which rapidly grew larger. When seen by the doctor the cyst had spread until it occupied part of the cornea, and it could plainly be seen that the cyst had invaded the corneal walls, and that both the front and back walls of the cyst were formed by corneal tissue, the cornea still remaining transparent. The tension of the cyst was about that of the eye. The conjunctiva was opened over the cyst, and it was found the outer wall was composed of sclerotic and corneal tissue. A small puncture made through the wall allowed quite a little thin, transparent fluid to escape, and a larger incision showed the inner wall of the cyst to be also composed of scleral and corneal tissue. Nothing was found in the cyst with the exception of this clear fluid. It healed rapidly, and the two walls united with obliteration of the sac.

Rogman.—A little girl, æt. 13 years, had a tumour of the left eye since birth, which had grown gradually larger. She had occasionally complained of the sensation of a foreign body in the eye.

On the sclera down and in from the cornea, on which it trespassed, was a trilobed swelling 8 mm. long and from 2–5 mm. broad. It was closely applied to the cornea throughout its whole extent. It differed but

little in colour from the bulbar sclera in the neighbourhood. It was semitransparent and was absolutely fixed to the sclera. The eye was in every other respect normal.

The anterior wall of the cyst was removed with the conjunctiva lying over it. Some clear fluid escaped, and the inner wall of the cyst was quite smooth. Through this could be seen the ciliary body adjacent, so much thinned was the sclera.

Histological examination showed the tissue removed to consist of scleral tissue covered by conjunctiva and conjunctival epithelium. There was no epithelial or endothelial lining, for which a particular search was made.

Lagrange.—A lady, æt. 25 years, the subject of high myopia, in August, 1898, submitted to the operation of tenotomy of the right external rectus. The muscle was separated in the usual way and two points of conjunctival suture completed the operation. Three months later the patient returned with a small transparent swelling, irregular in shape, independent of the conjunctiva and firmly adherent by its base to the sclera. The diagnosis of cyst was evident. The patient refused to allow it to be removed or even an incision to be made at that visit. She returned a month later: the cyst was much larger. A cut with the scissors sufficed to rid the patient of it, and since then she has been quite well.

Wernicke.—This occurred in a little girl, æt. 5½ years. At the upper edge of the cornea was a cyst in size and shape like a bean, with its concave side towards the cornea reaching to the limbus. The cyst was immovable, tense and not painful on pressure, its contents colourless and clear like water. The parents stated that it had been present since birth, and that it had grown slowly without pain or signs of inflammation. It closed up after removal of the anterior wall, which was quite separate from the conjunctiva and formed of sclera. There was no microscopical examination. Wernicke considered it to be congenital in origin.

Villard.—A little boy, æt. 5 years. A small swelling was noticed in the right eye immediately after birth. This swelling remained unchanged for four years. At this age the child had an attack of measles, and a little after the parents noticed that the tumour seemed to increase in size. It caused neither pain nor other symptom. The child had no congenital anomaly, had good health, and had never been the victim of any accident to his eye whatever.

The lower lid was apparently separated from the eye, since it was prevented by the tumour from being applied exactly to the globe, and as a result there was some epiphora.

At the inner part, and slightly below, intimately attached to the globe, was a tumour, slightly prominent, the size of a small bean. This tumour lay on the sclera, just beside the cornea, on which it encroached about 1 to 2 mm. It was relatively transparent and contained a clear fluid. It was covered by conjunctiva, and was very slightly vascular. It was not tender, and was intimately adherent to the sclera. This eye and also the left eye was quite healthy.

The conjunctiva was dissected from the tumour, which was found to be formed by a true splitting of the scleral tissue. The cyst was punctured and a clear fluid escaped without any trace of hydatids or hair. The deep surface of the cyst was bright and pearly exactly like that of the sclera. There was no trace of communication with the interior of the eye, whose tension was unaffected. The deep surface was gently curetted and wiped over with Flemming's solution, and the conjunctiva sutured over it. The child made a good recovery and was well eleven years later, the site of the tumour appearing grey as a result of the thinning of the sclera in this situation. The anterior wall of the cyst was fixed in Flemming's solution. The wall of the cyst was formed of scleral tissue lined by stratified epithelium exactly like that covering the conjunctiva.

Villard considered this cyst to have developed by an inclusion of conjunctival epithelium in the scleral tissue at the time that the sclera has not yet taken on the state of an independent structure, when it consists merely of a condensation of periocular mesoblast. At this time it is easy for some proliferating epithelial cells of the conjunctival tissue to be formed among the cells of the tissue which is to form the sclera later on.

This paper is illustrated with microphotographs not only of the cyst but also of developing eyes of the sheep, to show how inclusion of conjunctival epithelium may take place.

Rubert.—In this case the patient was a peasant from Little Russia, a man, æt. 22 years. He had noticed a swelling on the eye since eight years of age, which had gradually increased in size without pain or inflammation. Apart from this he had always been quite healthy. During the past year he had had troublesome epiphora, which had caused distortion of vision. He stated he knew of no injury to the eye.

There was slight ectropion of the left lower lid in its inner half, and over the whole of the lower scleral area with the exception of a small part at the outer canthus the conjunctiva appeared like a bladder. On separating the lids a cystic new growth appeared, approximately bean-shaped, with its concavity towards the limbus and involving the whole of the lower half of the conjunctiva. It had a broad base and was immovably fixed to the sclera.

It was broadest in its nasal half, where it reached the inner canthus, extended downwards into the fornix, and became gradually narrower towards its temporal part, being bounded above by the limbus. It measured 8 mm. in breadth at its nasal extremity, and although its surface here was irregular, nevertheless it was everywhere bright. The cyst was of the same colour as the sclera, semi-transparent, fixed to the sclera, and the conjunctiva over it quite movable. There was little injection of the con-

junctiva, which was everywhere smooth and bright. The cyst was tense and not painful to pressure. The cornea was normal in size and appearance, iris, anterior chamber and vitreous normal. There was myopic choroidal atrophy, and the vision with −8·00 D. sph. and −3·00 D. cyl. ax. 55° less than $\frac{6}{12}$. Tension normal.

The movements of the eye were not much affected, and there was no diplopia. Right eye normal with full vision.

The anterior wall of the cyst was removed after reflecting the conjunctiva. The walls were white inside, and there was no communication with the interior of the eye. The contents were clear and colourless. At the site of the cyst there remained a depression distinguishable from the rest of the sclera by its light colour, and over this the conjunctiva was drawn, but this portion sloughed. Eighteen months later the eye was quite well, and the depression of the sclera still remained.

A most complete histological examination was made. The inner layer of the cyst consisted of stratified epithelium, the outer layer being cylindrical. In places there was some pigment, which appeared as granules in the cells, the basal cells containing most. The staining reaction for iron was positive. The epithelium was everywhere smooth, except in its nasal part, where it was a little irregular. The tissue under the epithelium was of the same structure as the sclera, containing elastic-tissue fibres. Some pigment containing iron was also found among the fibres. In the episcleral tissue was found an accumulation of young connective-tissue cells, with increase of endothelial and polymorphonuclear cells, all of which were more numerous in the nasal part. Here the sclera showed a much looser formation; the nuclei of the fixed cells stained less deeply. Here was found vegetable foreign matter. It consisted of fibres and little hairs, probably from a particle of straw, and also pieces of needle-wood (pine-wood), and around these inflammatory reaction was more marked. These foreign bodies did not appear to lie quite free in the tissue, but to be separated from it by a

narrow cleft, as if they were lying in cavities; in the same neighbourhood were found islands of epithelium, situated between the sclera and episclera. This epithelium was not derived from the lining of the cyst, but from the conjunctival epithelium.

Perrod.—This case occurred in a girl, æt. 12 years. The sight of the right eye had been lost four years previously from a penetrating wound. The eye became shrunken and painful, and was for this reason removed.

Up and out from the limbus was a violet-coloured patch, which microscopically proved to be a cyst larger than the anterior chamber and situated entirely in scleral tissue. The anterior wall was formed of scleral tissue, and its posterior of cicatricial tissue secondary to the perforating wound. The cyst was divided into two parts by strands of fibrous tissue, and there was also a smaller cyst in the sclera. All the cavities were lined by stratified epithelium in several layers, the deeper layers cuboidal and the more superficial flattened. Some of the sections showed the origin of the epithelium from the conjunctival epithelium near the limbus

De Lapersonne.—A woman, æt. 19 years, had received a perforating wound of the right eye when three years old with a knife. She had noticed for several years a whitish swelling in the lower part of the eye. When seen by de Lapersonne the eye was blind and painful, and was therefore removed. This swelling occupied the lower part of the eye to its inner part and encroached upon the cornea, but the greater part was in the sclera. It was white, covered with conjunctiva, and was firmly fixed to the sclera. It measured 5 mm. by 9 mm. Microscopical examination showed the cyst to be covered with conjunctiva, and its walls to consist entirely of scleral tissue. It was lined by stratified epithelium, resembling the conjunctival epithelium.

Our own case was originally under the care of Dr. Leighton Davies, of Cardiff, and we have to express our thanks to him for his courtesy in allowing us to publish it.

A young lady, æt. 16 years, had had a left convergent strabismus for many years. In 1918 Dr. Leighton Davies performed an operation, dividing the left internal rectus muscle and advancing the left external rectus muscle, using silk sutures, and passing them through the episcleral tissue and superficial layers of the sclera, above and below the cornea.

At the end of two months a swelling appeared above the cornea, and a little later one similar below the cornea; these swellings had gradually increased in size.

The sight in the left eye had always been defective.

When seen on August 11th, 1920, the eyes were quite parallel, and movements full in all directions. The lids of the left eye were more prominent than those of the right eye, but there was no proptosis. To a superficial glance there seemed very little amiss, as the space between the edges of the lids and the edge of the cornea was only a trifle less than in the right eye. Upon asking the patient to look upwards and at the same time drawing down the lower lid, a pearly-white swelling sprang into view (see Pl. I, fig. 2, p. 138). It was situated at the corneo-scleral margin, shaped like a kidney bean and lying with its greater diameter horizontal, 17 mm. long and 5 mm. broad at its middle point. Its concavity coincided with the corneal margin, and where it impinged upon the cornea there was a linear opacity, such as one sees in an arcus senilis.

Above the cornea was a similar swelling, broader, but not so long. It impinged upon the cornea, in which there was a similar opacity near the limbus. The swelling measured 12 mm. in length and 7 mm. in breadth. Over the swellings were a few branches of the anterior ciliary vessels, and the eye as a whole was free from congestion. The eye appeared in all other respects quite healthy; the cornea bright, the anterior chamber of normal depth, the iris bright and pupil active, the lens and vitreous clear and the fundus healthy. The tension was normal and the vision $\frac{6}{36}$.

Upon further examination the swellings were found to be firm and apparently cystic, quite immovable upon the sclera; the conjunctiva moved over them, and they were not tender to touch. These two observations made it impossible that they were purely cysts of the conjunctiva, which appear to be fairly common after injury and operations for squint. It was also unlikely that they were connected with the interior of the eye as the anterior chamber was of normal depth, and slight pressure on the swellings did not cause any alteration in their size or any alteration in the depth of the anterior chamber. The condition was therefore diagnosed as an implantation cyst of the sclera from the epithelium of the conjunctiva.

Operation.—A horizontal incision was made over the middle of the lower swelling with a Desmarres secondary cataract knife through the conjunctiva only, which could then easily be dissected from the exposed wall of the swelling. The cyst could not be dissected out of its bed, and was found to be a swelling of the scleral tissue itself, immovably fixed. An incision was made into the cyst, which immediately collapsed owing to the escape of some colourless limpid fluid, in which there was no solid matter. The superficial wall of the cyst (as it proved to be) was carefully removed with scissors, including some of the superficial corneal substance into which the cyst had burrowed. The inner surface of the cyst was quite smooth everywhere, and over the floor formed by the sclera proper the conjunctiva was drawn and sutured. When the eye was examined a few days later the conjunctiva had retracted from its position on the floor of the cyst, and later became adherent by its edge to the cut edge of the cyst floor. The wound healed without any complication, and ten days later the upper cyst was dealt with in the same way. It proved to be exactly similar to the cyst below the cornea.

In neither was there any communication with the interior of the eye. The portions removed were immediately placed into Zenker's fluid for microscopical examination.

There are certain points of clinical resemblance in the majority of the cases, of which the case published here may be taken as a description. These cysts occur in young individuals, thirty years being the maximum limit in age; they gradually increase in size from the time at which they are first noted, and are painless in their growth. Frequently they are shaped like a kidney-bean, the concavity of which abuts upon the cornea, which opposes a considerable barrier to their extension, although the cyst may invade the cornea and cause the corneal substance to form part of its containing wall. They are all immovably fixed, and so tense that moderate pressure does not alter their shape. The conjunctiva is freely movable over their surface and shows no signs of inflammation.

The cases may be divided into three groups:

(1) The congenital cysts, those that have been noticed at birth, and of which there are three examples, those of Villard, Rogman and Wernicke.

(2) Those in which no cause has been ascribed, and in which from the history no injury can definitely be presumed. These are Lawrence's first case and those of Colburn and Waldhauer.

(3) Those in which an injury has been definitely stated or may reasonably be assumed: in this group fall Lawrence's second case, and those of Lagrange, Rubert, de Lapersonne, Perrod, and the case reported below.

Of the first and third group we have detailed pathological reports, and all, with the possible exception of Rogman's case, give almost exactly similar descriptions. As is stated later, there is some doubt as to the description of this case, as the published illustration of a microscopical section of the wall of the cyst is similar to the sections seen in our own case.

Pathological Report.

Macroscopical examination.—The first cyst removed was rather lacerated and did not make a satisfactory

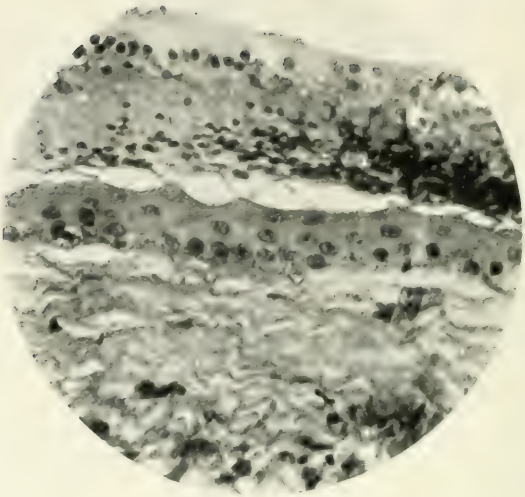


Fig. 1.

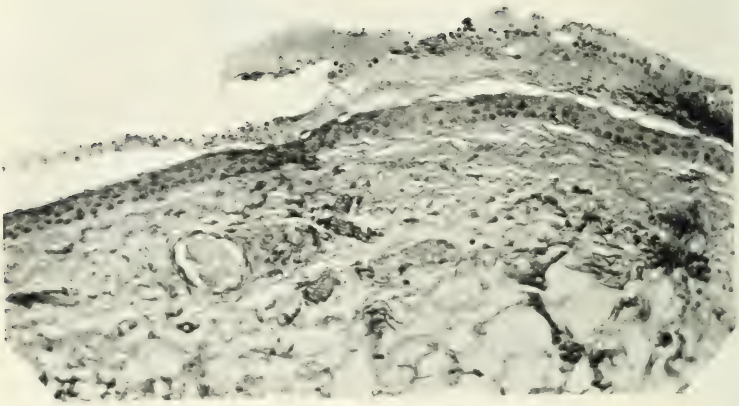


Fig. 2.

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PLATE IX.

Illustrates Mr. Charles Goulden's and Mr. Maurice H. Whiting's paper on Epithelial Cysts of the Sclera (p. 316).

Fig. 1.—Under high power magnification shows epithelial *débris* in the cyst, the stratified squamous epithelium and the scleral wall.

Fig. 2.—Shows the above under low power magnification with a large vessel in the scleral wall.

specimen. The second was more complete, and formed a curled-up sheet measuring 7 mm. by 3 mm. and about 0·5 mm. thick, though this was rather variable.

The specimen was fixed in Zenker's solution for twenty-four hours and then after dehydration was embedded in paraffin. To the naked eye the cyst appeared regularly oval in shape with a slit up the long axis; there were no projections to indicate a solid or tubular epithelial connection either with the surface or the interior of the eye. It was brownish in colour owing to the action of the fixing fluid.

Microscopical examination (see Pl. IX).—The sections formed an incomplete oval ring, the inner surface of which was lined with stratified epithelium, which varied in thickness and character. In most places it was composed of four or five layers of cells, the outer one being cubical when cut normal to the surface and polygonal in tangential sections. The cells then became successively more flattened, the inner ones being squamous. All the cells, including the most flattened ones, had definite nuclei which stained well with hæmotoxylin and had a granular structure. The protoplasm of the cells did not exhibit any granulation. In other places the epithelium was only two or three cells thick and did not exhibit flattening of the inner layer. There was no sign of hairs or other skin structures. Outside the epithelium the wall of the cyst was composed of two layers, both fibrous, but the inner one compact and the outer rather loose. These fibres were mostly cut longitudinally and were very undulating or corrugated. They showed up well with van Gieson stain, *i. e.* bright red from the fuchsin. The fibres were arranged roughly in lamellæ and between the lamellæ were cells which resembled corneal or scleral corpuscles. There were numerous vessels in this part of the cyst-wall and they were mostly filled with blood. They were large relatively to the size of the cyst and appeared to be composed only of an endothelial lining. There was no free blood in the cyst-wall, but a few red cells were seen on the outer surface.

No muscle-fibres were seen in any part of the sections. There was no inflammatory infiltration in any part. The interior of the cyst contained a certain amount of *débris*, in some cases applied closely to the epithelial wall. Generally this was structureless, but in places isolated nuclei which stained poorly were seen. No foreign bodies were seen in the cyst either with the naked eye or microscopically.

Pathological Summary.

The cyst is lined with stratified squamous epithelium, and the remainder of the wall is formed of fibrous tissue resembling sclera and probably derived from that structure. In view of the absence of a foreign body from the interior of the cyst and of any signs of inflammation, the cyst must be considered a traumatic implantation cyst and not dependent on inflammatory reaction.

It is interesting to compare and contrast the histology in this case with that in previous cases. Rogman states that no sign of epithelial or endothelial lining to the cyst was found in his case. The illustration, however, closely resembles the sections from our case, and one cannot help wondering whether he did in reality remove conjunctiva with the cyst-wall. If he did not, what he describes as conjunctival epithelium is really the epithelial lining of the cyst. This suggestion is supported by the fact that there is no lymphoid tissue beneath the epithelium, which one would expect if it were in fact conjunctiva. He also expressly states that when he had removed the anterior wall of the cyst he found that the interior was everywhere smooth—a fact pointing very strongly to an epithelial lining. There is a close resemblance between the illustrations of his own case and that of Villard and our own sections.

Rubert's case exactly resembles ours in histological detail with the exception that in his there was evidence of numerous injuries with implantation of epithelium, and there was also vegetable *débris* in the cavity. The case

described by de Lapersonne was of a more complicated nature, since there had been a penetrating wound of the globe. There was a communication between the cyst and the anterior chamber with extrusion of uveal tissue into part of the cyst, and the potential anterior chamber was partly lined with stratified epithelium. Secondary glaucoma had ensued.

In a case following a perforating injury of the globe reported by Perrod the cyst was binocular, and its wall formed partly of scleral and partly of cicatricial tissue. One interesting and important point in his sections is that he could trace the conjunctival epithelium at the limbus passing down to the cyst, and of this he gives a micro-photograph.

In view of the suggestion of Lagrange that some of these cysts are congenital it may be mentioned that congenital epidermoid cysts are described in general pathology. They are usually small and frequently multiple, have a well-formed epidermal lining, sometimes with papillæ but no dermal structures.

The tumour known as "cholesteatoma" which occurs in the brain in connection with the meninges is of this nature, and its structure shows a close resemblance to the cysts under discussion, since it consists of lamellated wavy or scaly material enclosed in a wall of stratified squamous cells. Traumatic cholesteatomata have been described.

The micro-photographs were kindly taken for us by Sir William Lister, to whom we offer our grateful thanks.

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(3) Lagrange.—*Tumeurs de l'Œil*, i, Paris, 1901.

(4) Lawrence.—Treatise on *Diseases of the Eye*, Philadelphia Edition, 1847, p. 335.

(5) Perrod.—*Ann. di Ottal.*, v, xliii, p. 111.

(6) Rogman.—*Ann. d'Oculist.*, cxvii, 1897, p. 115.

(7) Rubert.—*Klin. Mon. f. Aug.*, xlviii, 1910, pp. 145–154.

(8) Villard, H.—*Ann. d'Oph.*, xxx, 1910, pp. 36–43.

(9) Waldhauer.—*Petersburger Med. Zeitsch.*, 1866, pp. 337–352. Extracted in *Zentralbl. f. Med. Wissen.*, 1866, p. 48.

(10) Wernicke.—*Archiv f. Augenheilk.*, 1907.

Sir William Lister said: I thought it might be of interest to members of the Society if I showed as an appendix to Mr. Goulden and Mr. Whiting's interesting paper a few sections illustrating epithelial ingrowths or implantation in other parts of the eye. (1) The first specimen is one of implantation cysts of the cornea, following tattooing. The lining of the cysts probably in all cases has connecting links with the surface epithelium, though this is shown only in a few of the sections. (2) Shows the ingrowth of the epithelium in a cataract extraction wound. (3) An implantation cyst in the anterior chamber following a penetrating injury. This photograph was taken from a section kindly lent me by Mr. Juler. (4) Epithelial cyst of the iris from a French liaison officer. There was no history of injury in this case, but a possible explanation is that some needle or pin entered the eye when he was a baby. I referred to this case at the meeting of the Ophthalmic Section of the Royal Society of Medicine some months ago, and suggested that cases of epithelial cyst occurring with no history of injury might be due to a baby either rolling on to, or being put down quickly on to, a pillow in which there was a needle or pin; a penetration might easily take place without anyone knowing of this injury. This cyst has a peculiar nipple-like projection from the anterior surface, which is seen in the section to consist of layers of fibrous tissue similar to those one sees on the back of the cornea after chronic inflammation, having been laid down by endothelium. (5) Epithelial

cells growing on the anterior surface of the iris. The jocular arrangement of round cells looking one over the shoulder of the other is in striking contrast to the usual stratified arrangement of cells met with in certain cases where the growth has extended into the A.C. from the C.B. Since these intra-ocular implantations occur as a result of penetrating injury, whether intentional or accidental, either from extension from the surface or by sowing of the cells carried in by the instrument, it is extraordinary that they are not more common. Why do they not occur in every case? One would have thought that with every penetrating injury cells would be brought in by the knife, and especially whenever silk is drawn through the conjunctiva, cells would become embedded into the deeper conjunctival or episcleral tissues, and yet such cysts are comparatively rare. One wonders what is the reason that such cells introduced proliferate in one case, while in another they die or remain quiescent. I think this would be an interesting point to discuss.

Mr. Cyril Walker said that in 1891 he saw a man, æt. 35 years, who had had tenotomy of both internal recti which was followed by divergence. Afterwards tenotomy of both external recti was done, and then in 1886 some sort of advancement operation was performed on the right internal rectus. A few months afterwards a swelling formed externally, behind where the insertion of the internal rectus had been; it attained to the size of a split-pea. When he saw the man in 1891 there was a translucent, slightly bluish swelling, looking like a cyst, and when the pupil was widely dilated it was possible, with very oblique examination with the ophthalmoscope, to see a corresponding intra-ocular swelling. Obviously some traumatism at the time of the attempted advancement of the internal rectus had resulted in this swelling, which gradually increased to 7½ mm. in diameter, and then, apparently, remained stationary; from 1891 to 1914 it had not altered at all. The internal appearance resembled that of sarcoma, especially as there was a

chain of vessels over it. The eye was very divergent, but with sph. + 1, cyl. — 1·5, saw $\frac{6}{12}$.

Mr. J. H. Parsons said he thought it was doubtful whether the term "implantation cyst" applied to this group. Years ago attempts were made to implant epithelium on the irides of rabbits, but in the vast majority the attempt failed. One found all sorts of gradations: in some very small cholesteatomatous masses of cells on the iris, in others tiny cysts, and only rarely considerable extensions of epithelium, showing that the conditions had to be extremely favourable in order that epithelium might grow under these abnormal circumstances. Where secondary glaucoma had followed operation and the eyes had been excised, in a fair proportion one found the anterior chamber, or a considerable part of it, lined with epithelium, and in most there was continuity of epithelium from the surface down the whole tract of the wound. Very often these eyes had existed in the body as blind eyes for a considerable time, and it was impossible to prove complete communication between the surface and the interior of the eye. He concluded, from the observation of those cases, that they were not true implantation cysts; the epithelium grew down the track in the characteristic way in which epithelium did grow over a surface, and continued to grow inside the anterior chamber. It might eventually be broken by separation and destruction of certain parts of epithelium, so that the epithelium in the interior of the eye seemed separated from that on the surface. Mr. Collins wrote on the subject many years ago, and called them implantation cysts, but the application of the term to a whole group of cases was misleading. He thought it would be better to apply the term to cases of true implantation of epithelium without continuity, in which case implantation cysts would probably be very rare.

Mr. A. L. Whitehead said he had seen two cases which supported Sir William Lister's theory as to how some of them arose. He thought the puncturing of the eye

accidentally by a needle being left on the child's pillow was quite likely. One of the patients was æt. about 4 years and showed a scar at the corneo-scleral junction. There was a small translucent cyst in the anterior chamber at the outer part of the iris and in immediate continuity with the scar. There was no known history of injury at any time. That cyst remained small; he saw it several years, and it caused no discomfort, and did not increase in size, therefore he left it alone. The other case, a child, æt. 9 years, he saw only recently: it had been seen by a colleague some years ago. Here there was a similar small scar. There had been a perforating wound causing iritis, which had subsided under treatment, leaving adhesions. His colleague saw the child when it was between two and three years old. He saw the case last week, and secondary glaucoma had come on. He did iridectomy, and the child was now all right. The puncture was such as would be produced by the entry of a sewing needle, but no history of any injury could be obtained.

Mr. E. Treacher Collins asked what Mr. Goulden meant by "*congenital* implantation cyst"; it was a term he could not understand. He believed the term "implantation cyst" was first used by Sir John Bland-Sutton. His attention had been called to Sir John's little book on dermoids, in which the author described cysts of that nature in the flanks of oxen, which had been caused by prods with an iron goad. It was Masse who wrote the classic article on implantation cysts of the eye to which Mr. Parsons referred. He transplanted eyelashes, pieces of skin and conjunctiva into the eye, and found that cysts grew from them; these were true implantation cysts. He (Mr. Collins) had recorded* several cases which he described as implantation cysts of the cornea. One, of which there was a specimen in Moorfields Museum, showed a very similar condition to Mr. Goulden's case; it was situated

* *Researches into the Anatomy and Pathology of the Eye*, 1896, pp. 72–82.

partly in the cornea, partly in the sclerotic. In another case, in which the wound was inflicted with a screwdriver, there was a sub-conjunctival implantation cyst. Serial sections of the specimens had not been cut in his cases, and unless that were done one could not say for certain that the cysts were not produced by downgrowths of epithelium through a wound. The most interesting class of cases clinically of this sort were those which occurred after cataract extraction. The epithelium spread down in the wound, as Sir William Lister showed in his beautiful section, and if the whole length of the wound remained open it extended into the anterior chamber, and would spread entirely round it. Mr. Richardson Cross sent him a specimen of an eye in which he had performed a cataract extraction. The patient had good vision for a time, and then developed glaucoma, so that the eye had to be excised. He (Mr. Collins) cut sections, and found epithelium lining the whole anterior chamber. Subsequently in a case of glaucoma after a cataract extraction, merely from the clinical appearance of the case, he was able to diagnose that the same event had occurred—a diagnosis subsequently confirmed by pathological examination.

Mr. T. Harrison Butler said that a month ago his assistant told him there was a baby in the Out-Patient Department with a dislocated lens, and the condition looked like it. There was a lenticular cyst in the situation shown by Sir William Lister. Examination, however, showed vessels on it, so that it could not be lens. When exhibited at the Midland Ophthalmological Society all present thought it was a cyst. A little later it was said that the baby had been in pain for a couple of days, and the cyst had flattened out and had obviously burst; there was blood on the iris and striate keratitis. He gave an anæsthetic and seized the cyst with forceps, and it came away easily, leaving an ordinary iris coloboma afterwards. He sent the specimen to Mr. Treacher Collins, who had cut it, and no doubt an account of it would appear in the

Transactions.* The child was only a month old when he saw it, and the mother had noticed a swelling when it was fourteen days old. There was no history of injury, and it seemed unlikely that injury there could have acted in so short a time. At all events, no scar was visible in the cornea.

Mr. C. GOULDEN said there were recorded two cases which corresponded with that described by Mr. Cyril Walker. One was described by de Lapersonne, the other by Perrod. The injury had been a perforating one; they did not happen at a squint operation, but were the result of injuries by sharp objects.

7. *A case of "neuroma" of the orbit.*

By Sir ARNOLD LAWSON and HUMPHREY NEAME.

(With Plate X, figs. 1 and 2.)

THE patient is a lady, who was æt. 39 years when she first consulted me in September, 1919.

She had then noted some mistiness of the right vision for about eight months. She was wearing, constantly, hyperopic glasses, right sph. + 1·5 D., left sph. + 0·5 D., and with these the vision in the right was $\frac{6}{6}$ and in the left $\frac{6}{5}$. Pupils equal but rather sluggish. The right disc was distinctly swollen and veins turgid. Superduction was slightly less on the right side than on the left, but there was no visible proptosis and no strabismus. Tested with Maddox rod there was very slight hyperphoria requiring a 1 degree deviation prism base down to correct. A course of iodide of potassium was ordered.

I saw her again a month later, and in the meantime a thorough pathological investigation including the Wassermann test was carried out. Nothing was found to throw any light on the swelling of the right disc. At this examination matters were found to be distinctly worse.

* See this volume, p. 454.

The right disc was distinctly more swollen, and allowing for the hyperopia a lens of sph. + 4 was needed to focus the summit of the swelling distinctly. Vision ($\frac{6}{9}$) was also not so good, superduction was distinctly impaired, and there was obvious slight but definite proptosis of the globe. The fields were normal.

I suspected an orbital growth and asked Mr. Somerville Hastings to report on the nasal sinuses, which he did. The report was entirely negative. An X-ray examination of the skull was also made, but there was absolutely nothing abnormal to be seen. I warned patient that operation might be advisable in the near future, and, on the understanding that she would return to me at once if the symptoms became worse, she went to her house in the North of England.

I did not see her again for seven months (April, 1920). Matters then seemed to be absolutely stationary so far as the proptosis, disc swelling and movement were concerned, but she had for some time felt a little dizzy when suddenly lifting her eyes, as when getting out of bed in the morning. The giddiness seemed entirely to be concerned with the defect in superduction, but lest it should possibly be connected with cerebral complications I called in Dr. Campbell Thomson, who could find no evidence of cerebral mischief or of any generalised nerve disorder.

Symptoms had now been noted for fifteen months, and most certainly the trouble must have been existent for some months longer than that. Consequently, and as no apparent progress in symptoms had been made in the last eight months, I resolved to temporise.

The patient came up again to see me in October, 1920, and was very cheerful about herself. She said she could see better and had very little dizziness. She had had a second course of potassium iodide lasting six weeks and thought it had done her good. The vision was $\frac{6}{9}$ as before, and the swelling of the disc seemed to be distinctly less. There was no increase in the proptosis or further limitation of movement. Call for interference was not

more evident than six months previously, and operative procedure was put off again.

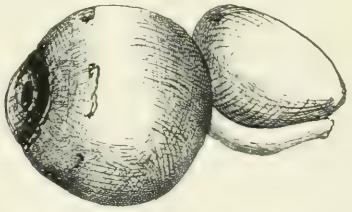
Early in February this year, four months after her last previous visit, she came again, and on this occasion for the first time since her first visit in September, 1919, it was obvious that her symptoms had progressed. The proptosis was decidedly worse and the globe was bulging directly forward in a marked manner. Superduction was a great deal more limited and the patient was increasingly conscious of diplopia and vertigo. Vision was $\frac{6}{18}$ and the disc seemed more swollen, requiring sph. + 6 D. to reach the summit.

I advised an exploratory operation without further delay, and sent the patient to Mr. Treacher Collins for a further opinion. He agreed with me that there was a non-malignant growth probably in connection with the optic nerve. He hazarded the diagnosis of a "neurofibroma," which was a very good guess indeed.

Two or three days later I made an exploratory incision along the upper and outer orbital margin dividing the external tarsal ligament to give more room. I could feel a definite hardness just behind the globe and above the nerve, but it was too far back to examine. Further operation was therefore imperative, and two days afterwards I proceeded to try to remove the growth without extirpating the orbital contents. I divided the external rectus tendon at its insertion and passed my finger back. I could then feel the growth lying inside the cone of muscles on and above the nerve and stretching right away back to the foramen. It was obviously impossible to remove it without sacrificing the eye or lacerating the ocular structures so much that the eye would have been useless. I had difficulty in getting the scissors round the nerve at the foramen, so close was the growth to the orbital apex, but once that was accomplished there was very little trouble in completing the shelling of the growth with the eye. The tumour lay free in the orbit without any adhesions except a loose fibrous band holding it down to the optic nerve-sheath.

Mr. Humphrey Neame very kindly undertook the examination of the growth, and he will give a full account of it. I confess that I was much puzzled myself at the microscopical appearances, and submitted it to Prof. McIntosh, Director of the Bland-Sutton Institute of Pathology, Middlesex Hospital. You will see (p. 340) that he agrees with Prof. Turnbull of the London Hospital, to whom Mr. Neame submitted the growth, in regarding it as a true neuroma. Possibly, I think, it may have arisen in connection with the frontal branch of the ophthalmic nerve, as the patient for some time previous to operation had complained of intermittent neuralgia over the supra-orbital

Fig. 80.



region, and for a full fortnight after removal of the growth this neuralgia was even more persistent and troublesome.

Pathological Report (Plate X).

The specimen preserved in formalin consists in an eyeball and a loose mass of lobulated adipose tissue containing an egg-shaped tumour of size 25 × 18 × 16 mm. (Fig. 80).

The eyeball is of normal appearance externally, and after bisection shows no change apart from slight prominence of the optic papilla. Microscopic sections reveal a moderate degree of papilloedema. The optic nerve in transverse section, a few millimetres behind the optic disc, is of normal appearance, and possesses a central artery with layers of usual thickness, without any reduplication of the elastic layer in the intima, as stained by Weigert's elastic stain.

To the tumour passes a strand of fine, smooth and white tissue, which becomes lost in the capsule. The

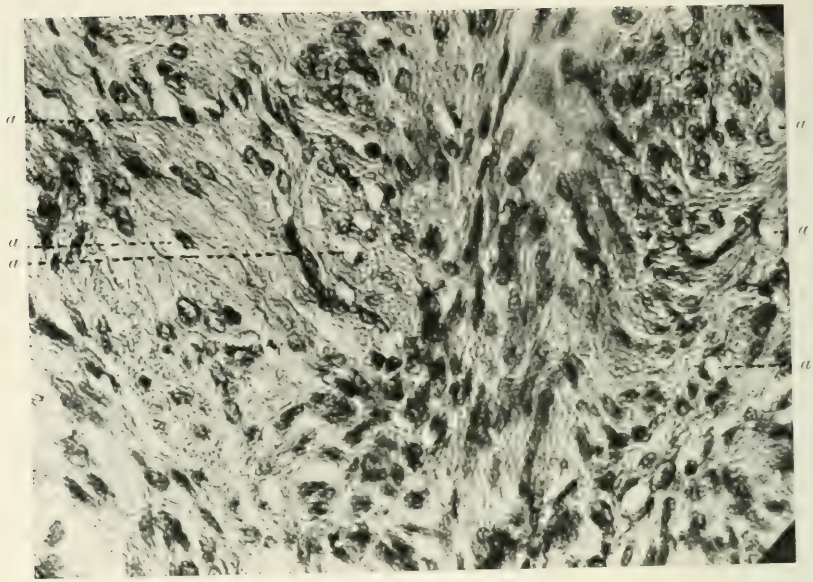


Fig. 1.

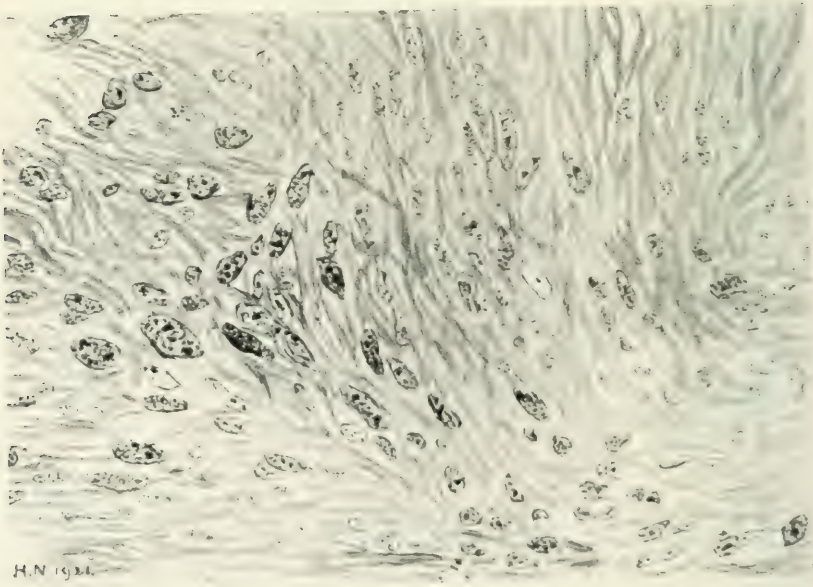


Fig. 2.

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PLATE X.

Illustrates Sir Arnold Lawson's and Mr. Humphrey Neame's paper on A Case of "Neuroma" of the Orbit (p. 335).

Fig. 1.—(Micro-photograph.) Shows many of the fibres in transverse section. The letter *a* indicates some of the hollow cylinders in transverse section, with peripheral nuclei, as described in the text.

Fig. 2.—(Outline drawing with prism projector, details of nuclei filled in under examination with $\frac{1}{12}$ oil immersion and No. 2 eye-piece.) Shows degree of variation in size of nuclei, and the presence of an occasional large nucleus. The nuclei which appear circular are probably in all cases nuclei similar to the oval, but seen in cross section. The nuclei have one or two small nucleoli and a granular structure.

tumour is discrete and has a smooth surface. It is firm to the touch, with slight elasticity. On section it is seen to possess a delicate fibrous capsule, within which it is entirely limited. The structure to the naked eye is homogeneous; the tissue is grey-white in the periphery and whiter in the central portion, with a few brown-stained areas at the section of minute blood-vessels. On examination of the cut surface with a hand-lens a finely-streaked irregular pattern is to be seen.

A portion of the tumour was embedded in paraffin, and sections were stained with hæmatoxylin and eosin, and with Weigert's iron-hæmatoxylin and with Van Gieson's stain. The latter show a thin capsule of closely-set red-stained collagen fibres. This fibrous tissue is seen to extend for a short distance into the tumour.

A report, which Prof. H. M. Turnbull, Director of the London Hospital Pathological Institute, kindly made, follows, and describes the minute structure in detail.

PROF. H. M. TURNBULL'S REPORT.

"In places the tissue is composed of bundles of long, often sinuous, fibres, which are stained yellow in van Gieson, are of even breadth, and are furnished with nuclei at intervals. The fibres are seen frequently to be hollow cylinders. In a few places similar fibres are stained red by van Gieson's method. The nuclei in such longitudinally cut bundles are oval rather than rod-shaped. Where these bundles are cut transversely the majority of the fibres have the appearance of transversely cut hollow cylinders, and the nuclei are few in comparison with the number of fibres. Where the fibres are represented by hollow cylinders the nuclei usually lie in the periphery of the cylinder. The differentiation of the transversely cut fibres is so poor that it is not possible to determine with certainty whether each hollow cylinder represents a single fibre, whether the fibres are round on cross-section, and whether the nuclei really lie in the periphery of the fibres. But even without information concerning the actual shape

of the cross-section of the fibres and the position of the nuclei therein, the features mentioned above show that the tissue is of the nature of nerve rather than of involuntary muscle. The tumour has the characters of a neuroma.

"In the greater part of the tissue it is impossible to estimate the length of the fibres in the interlacing bundles. The fibres here may only be elongated mononuclear cells. But there are no cells which have scanty cytoplasm and are of round or polygonal shape. Further, the variations in the size and shape of the nuclei are slight when the effect of section through different planes is taken into consideration. The growth is, therefore, not obviously 'atypical,' so that there is no definite histological evidency of malignancy."

Dr. James M. McIntosh's Report.

"I have examined the sections of the tumour removed from an orbit and find that it consists mainly of cellular elements with a small amount of fibrous tissue. Here and there throughout the sections are areas of proliferating cells, somewhat spindle-shaped and with elongated nuclei; away from these areas the cells become more and more elongated and the nuclei long and thin. In places these nuclei appear to be rod-shaped. Cross-sections of these cells show clear round spaces with small nuclei at the side, apparently a transverse section of the elongated cell. From the general appearance of the tissue, and particularly from that of the elongated cells and their nuclei, I am in agreement with the diagnosis of neuroma."

Further pathological investigation of the above-described tumour has been carried out since the meeting of the Ophthalmological Society. Staining of the tissue, after two months' fixation in Muller's fluid, by the Weigert-Pal method, failed to reveal any trace of medullary sheath, although a control specimen of neuro-fibromatosis of eyelid, fixed slightly longer by the same method, showed very definite medullary sheaths. Mallory's phospho-

tungstic acid and hæmotoxylin stain did not reveal any neuroglia fibres in the tissue. The tumour is therefore composed of non-medullated fibres—a neuroma amyelinicum.

Literature.

In his *Neoplastic Diseases*, 1919, Ewing (1) classifies neuromata as (*a*) neuroma ganglionare—new growth of nerve-cells and nerve-fibres; (*b*) neuroma myelinicum—new growth of medullated nerve-fibres; and (*c*) neuroma amyelinicum—new growth of non-medullated nerve-fibres. He also quoted Virchow's classification of (*a*) true neuroma—a tumour composed of ganglion cells and nerve-fibres which are usually non-medullated; and (*b*) false neuroma—a growth of fibrous tissue with some endothelial cells, and with degeneration of the nerve-fibres themselves.

Types of these tumours are described—a ganglio-neuroma in connection with the pleura in a woman, æt. 35 years, by Loretz (2), and multiple subcutaneous tumours in a young girl, which were composed of ganglion-cells, non-medullated fibres, and some medullated fibres, by Knaus (3).

As far as the orbit is concerned, a full description of a localised fibro-neuroma, which was not, however, definitely encapsuled, is given by Tertsch (4). This mass measured 3·5 by 2·75 by 2·5 cm., and had a small nerve entering it. The medullated fibres of this nerve entered and spread out fan-wise within the tumour. The centre portion of the mass consisted mainly of nerve-fibres: the peripheral parts contained more nuclei and much fibrous tissue. This growth was believed to be in connection with the lacrymal branch of the fifth cranial nerve.

A case of true neuroma was described by Bietti (5), but in this there were multiple neuromata from regeneration of ciliary nerves after optico-ciliary neurectomy.

Pathological descriptions of two cases of true neuroma of ciliary nerves in their passage through the coats of the eyeball were made by Fuchs (6). In both the tumours were extremely minute, and occurred in eyes the subjects of old irido-cyclitis.

References.

(1) Ewing.—*Neoplastic Diseases*, 1919, p. 411.
(2) Loretz.—*Virchow's Arch.*, Bd. xlix, 1870, s. 435.
(3) Knaus.—*Ibid.*, Bd. cliii, 1898, p. 29.
(4) Tertsch.—*Archiv f. Ophthal.*, lv, 1903, p. 121.
(5) Bietti.—*Ibid.*, xlix, 1900, p. 190.
(6) Fuchs.—*Tr. Amer. Oph. Soc.*, vol. xii, 1911, p. 786.

Mr. Treacher Collins said he had never before heard of a neuroma of a ciliary nerve. If this was the nature of the tumour in this case the occurrence of pain was well explained, for pain was one of the characteristic features of the well-known cutaneous tumours of nerves.

Mr. J. H. Parsons said the diagnosis of neuroma seemed a little doubtful, and he thought the specimen required more differential staining to make it quite certain.

Mr. G. Maxted asked whether Sir Arnold Lawson had not any misgivings that he might be dealing with a malignant tumour. The diagnosis of intra-orbital tumour was evidently arrived at some considerable time before an operation was done. Some of the symptoms suggested that the tumour was growing, especially the attacks of giddiness; this made one suspect that it might be beginning to spread through the optic foramen to the brain. He had been rather surprised that operation had not been recommended earlier.

The President said the interest of this case was both clinical and pathological. An explanation of the attacks of giddiness was important; there might have been some doubt about extension through the optic foramen. Sir Arnold did not say whether, since the removal of the eye and tumour, there had been any recurrence of the attacks or any disturbed health.

8. *Sir William Read, Knt., oculist to Queen Anne and to George the First, quack, mountebank.*

By R. R. James.

The contemporary records available for reference in attempting a biographical notice of Sir William Read are

not numerous; they consist almost entirely of his book, a copy of the second edition of which is in my possession. This book is stated to have been the work of an amanuensis, for Read was apparently unable to write.

The account of Read supplied in the *Dictionary of National Biography* is a very good one, and contains nearly all that can be discovered about him; in it will be found a reference to the *Spectator* (No. 547), in which Read is mentioned in company with John Moore of worm-powder fame, and Roger Grant, the King's other oculist, of whom an account will be found in the last volume of the *Royal London Ophthalmic Hospital Reports*, admirably compiled by the late George Coats. From the same source we learn that in 1694 there issued from York Buildings, Strand, his advertisement, "Post Nubila Phœbus, Nihil absque Deo," a copy of which can be found at the British Museum, and which I shall give at a later stage of this paper. Shortly after this date he advertised in the *Tatler* that he had been couching for thirty-five years, taking off wens, curing wrynecks and hare-lips without blemish.

Read was knighted in 1707 (July 27th), for his great services done in curing great numbers of soldiers and seamen of blindness, gratis, the notice appearing in the *London Gazette* of July 30th, 1705. The war then waging was of course the War of the Spanish Succession, and the destinies of this country were in the hands of one of the greatest military geniuses the world has ever known—John Churchill, Duke of Marlborough. Blenheim was won on August 13th, 1704, while in the same year, the Fleet under Admiral Sir George Rooke, foiled before Barcelona, on its return, took by surprise the fortress of Gibraltar; here we see the source of the supplies of gratis soldiers and seamen, the treatment of whom procured for Read his knighthood.

In 1705 he was appointed Oculist in Ordinary to Queen Anne, who, it has been stated, was very short-sighted. During this year there appeared a poem, entitled "The Oculist," a fulsome eulogy of Read, a sample of the

sentiments of which can be seen in Jeaffreson's *A Book about Doctors.* There is a copy of this in the British Museum; it is a small quarto pamphlet of twelve pages, viz. five pages introduction and 111 lines of poem. It is entitled "A Poem | addressed to | Sir William Read, Knt. | Her Majesty's Oculist in Ordinary. London, printed and sold by A. Baldwin, near the Oxford Arms in Warwick Lane. 1705."

From the introduction I extract the following: "Sir, In taking this way of giving you joy of the gracious Court-Favours You have lately received, I have at least this plea to encourage my presumption, That as your own public Reputation and deserts obtained You those Favours, 'tis but reasonable that the congratulation I make You on that subject should be publick too. . . . Your detractors flatter themselves with one considerable triumph over You, which is that You are not a Man of Learning and Languages, Yes, from this Battery they level their whole artillery against You, little thinking how weak a handle of offence Your Scholastic Adversaries have found in this objection, when (thoroughly examined) it rather redounds to Your Honour that You have made Yourself Master of so much true knowledge, by a natural Genius and Application, without the help of their learned Leading-Strings. . . ."

This preface certainly supports the insinuation made above that Read was illiterate.

In 1706 appeared his book, entitled, *A Short but Exact | Account | of all the | Diseases | incident to the | Eyes | with the | Causes | Symptoms and Cures | also | Practical Observations upon some | Extraordinary Diseases of the | Eyes*, by Sir William Read, Her Majesty's Oculist, and Operator in the Eyes in Ordinary. London: Printed and Sold by J. Baker at the Black-Boy in Paternoster-Row. Price, Bound in calf, 2/6.

On April 11th, 1711, Swift wrote to Stella: "Henley would fain engage us to go with Steele, Rowe and others to an invitation of Sir William Read; surely you have

heard of him; he has been a mountebank and is the Queen's Oculist. He makes admirable punch and treats you in golden vessels."

It is said that Read began life as a tailor. He died at Rochester in May, 1715, and was buried there, either in the church or cemetery of St. Nicholas. His widow continued his business in Durham Yard, Strand. I wrote to the sexton of the cemetery of St. Nicholas, Rochester, to try and get a copy of the inscription on his tomb, but it appears from his answer that the graveyard was levelled some years ago, at which time the tombstones were taken up and laid down flat, so that it was impossible to find out which was Read's grave. I received a copy of the entry of his burial, which took place on May 24th, and was informed that there is no monument to him in the church.

Unlike the works of the Chevalier Taylor, Read's book tells us nothing about himself. He belongs to an earlier period than the Chevalier, a time when medicine had hardly emerged from the astrological period, when all sorts of unsavoury messes were used in the treatment of disease—dead men's skulls and foxes' dung, etc. It is indeed amusing to find Read denying the virtue of the white part of hen's dung as an application for diseases of the eye. His book is rather a scarce item; the Library of the Ophthalmological Society does not contain a copy of it, but there is one in the Library of the Royal Society of Medicine.

He has the effrontery to entitle his first chapter, "Some errors committed by the pretended Practitioners for the Eyes." This chapter contains a short catalogue of most medicines commonly used for the eyes, together with the best method of using them; from this I cull the following: "Alum, Copperis, Salt, Sandiver and suchlike; these must not be too sharp, for sharp medicines destroy the visible spirits, and tho' the pain be eased and the rheum stayed, yet they remain with dull sight for ever."

"Juice of Agrimony, Celandine, Dazy roots, Horseleek and such like, to be used for small pearls, fresh, well cleaned and mixed with white of egg; if kept too long

these juices become soure, sharp and acid and offend the eyes."

"Lapis Calaminaris, Tutia, used in powder or water, so that they be well prepared by heating and quenching in children's urine, to be used for sharp defluxions."

"Oyl of wheat of peper and of snails are very violent and are not recommended."

"Medicines to be applyed to the forehead and temples that have an astringent quality are not fit to be used before the body and head be well prepared and purged."

"The white part of hen's dung and the juice of goose dung are not fit and proper medicines for any diseases."

"For the powder of the Hob goblin Shove, Nutmegs, Oyl and Rosemary to the head, Cammomil to the feet, Infusion of May weeds for a dyet drink, Licking the eye with the tongue" are all condemned.

"Fretting upon the Cornea with an eyespoon like a grater is good if properly used."

"To draw a cutting grass through the eye and to smooth it with a gold ring, cutting or scraping upon the cornea, wounds are healed, but scars never so; Webs upon the conjunctiva spread over the cornea (*i. e.* pterygium) are cut with good success if performed by a good artist."

Remarks on imperfect cataracts, web-like cataracts and mistakes and mismanagement, mostly of a self-laudatory nature, are followed by a sort of ophthalmic pharmacopœia, headed, "Because of want of due knowledge of the true temperatures of simples, very pernicious errours are committed in the cure of the eyes; I thought fit to insert here the natural temperatures and observations of most simples used in the diseases of the eyes, according to the opinions of the best approved authors." This pharmacopœia has a decided smack of Culpepper and of the astrological period of medicine.

These chapters are followed by a pseudo-anatomical description of the eye, its rampiers and defences, its coats, muscles, nerves, arteries, humours and kernels, the latter commonly called its glandules. Speaking anatomically this

is all very poor stuff, but doubtless Read knew his audience better than we should have done. 120 pages are occupied by an account of the diseases of the eye and their treatment; space only allows of a few extracts from this, the major portion of the book.

"Proptosis, called by the common sort goggle eye, needs no treatment if it be merely natural. The causes of a true proptosis are either severe head injuries or contusions to the eye itself; violent straining, strangling or choaking as appears in those who use wrastling, prolonged labour and tenesmus and it is also incident to musicians who use great blowings in horns or trumpets." This last cause is rather at variance with the teaching of a surgical teacher of mine, who used to impress on the minds of his dressers that the most usual accident to befall those who perform upon the cornet, in rainy weather, outside public-houses was a rupture of the urethra, behind an old stricture, leading to extravasation of urine, but that is by the way.

Treatment is by replacement of the displaced eye, a roller bandage to keep it in place, stupes, phlebotomy, purging, spare diet, etc. Pigeon's blood, or turtle's blood, hot in each case, is rather a favourite local application of Read's, and I may, perhaps, be allowed to remind readers of this paper that pigeons were also used for those *in extremis*, a live pigeon being divided, and the two halves bound on to the feet of the moribund patient; it does not seem to have occurred to the minds of the faculty that a hot-water bottle would have been just as efficacious—possibly more so.

Read's remarks on squint are interesting; one of its causes in his opinion is from keeping too much company with women, "the excess whereof strangely dissipates the spirits: most commonly this distemper is most incident unto children, presently after their birth, through the negligance of their nurses who set the cradle in which the infant lyeth, sideways to the light and not directly contrary to it, which maketh the children looking towards

the light, to turn the eye on that side towards it, and thus by continuance, they are accustomed to turn the eye awry, till the muscles have contracted a habit."

The treatment of the disease, "if it proceeds from repletions, softness and a palsey in some muscles, is to purge the brain, for which purpose let the patient chew things in his mouth, put sternutatories in his nose, use a good diet, and strengthen the part as much as may be with drying and resolving fomentations; if due to too much want and emptyness of the blood and spirits, the sick party must be nourished well on asses' milk; moist fomentations and pigeon's blood, dropped into the eye are very good." "Paulus Aegineta advises a mask for young children so that they may always look straight forward, an excellent description and portraiture of this will be found in *Ambroise Paré, his book.*" The old writers advised something red to be fastened to the temples and on the contrary ear to the turning awry of the eye, and to set the cradle with the contrary side to the light. In some of this we see the rudiments of the modern training treatment of squint.

A chapter is devoted to lice which breed in the eyelids, so we may presume that this condition was much more common than at the present time. Other chapters deal with trichiasis, ophthalmia, trachoma, ulcers on the cornea, etc. The web is a term used at times to designate cataract, and at other times pterygium. Couching was, of course, the only surgical treatment for cataract in those days.

I found the last forty pages the most interesting part of the book. An English translation of a letter from Le Jeune, Chyrurgion to the French King, deals with the case of a member of the Guise family, who was troubled with a condition like little lice on the white of the eye; this caused great irritation and resisted the orthodox treatment (what that was is not stated), and so the patient addressed himself to a certain woman living about Joynville, who in Le Jeune's presence took away very dexter-

ously and with very little pain, by means of a silver needle the worms and nits from the membrane.

Read's first puff is entitled "An extraordinary cure of the Gutta Serena, joyned with glaucoma, occuring in one Jeremiah Puttiford, of Watford, deprived of his sight eighteen months, by a violent contusion to the head and right eye." The faculty put his blindness down to a total obstruction of the optic nerves.

Read treated him with cephalics and cordial stomachics. This treatment having produced some slight improvement in the man's condition, and Read having made up his mind that the case was one of glaucoma, he proceeded to treat this with mallows, violets, eyebright, celandine and fennell, together with depletion; he then performed a couching operation and the man received his full sight.

Several cases of cancerous excrescency in the great corner of the eye (the region of the inner canthus) are detailed, one, the case of John Mackleton, of H.M. Horse Grenadiers, who had been wounded thirteen years previously at the siege of Limerick by a musket ball in this region. Read removed the cancer by means of a manual operation, stopped the hæmorrhage with his styptic water, prevented the recurrence of the growth by the application of some drying medicines, and in eight days' time restored the patient to his perfect sight.

Another case living at Hayes, near Uxbridge, suffering from a similar condition, was by God's blessing and Read's styptic water, cured after an operation, which cut out the cancer, root and branch. A similar result was obtained in the case of my Lord Mainard's butler, Mr. Seedmore.

Mrs. Noles, of Hedcox, in Suffolk, suffered from a wen of 10 lbs. weight on her arm; she was cured by means of an operation and the styptic water.

After describing a few cases of cancer of the breast which were cured by operation and the styptic water, Read goes on, "After this digression relating to various cancers, we will now return to the diseases of the eye."

He relates the marvellous results of couching in the aged, but enough extracts from this part of the book have been given.

This forms a convenient place in which to enter the following squib, published at the time Read received his knighthood :

"The Queen, like Heaven shines equally on all,
Her favours now without distinction fall.
Great Read, and slender Hannes,* both Knights, show
That none their honours shall to merit owe.
That Popish doctrine is exploded quite,
Or Ralph† had been no Duke, and Read no Knight,
That none may *virtue* or their *learning* plead,
This has no *grace*, and that can hardly *read*."

We now come to Read's advertisement, which I propose to give in full :

Post Nubila Phœbus. Nihil absque Deo.

A sheet about 15 in. by 9 in., printed in two columns on one side only. About one-third of the sheet is occupied by, in the centre, a picture of a patient, and sitting beside him on a seat the quack, in a very full wig, putting into the eye an instrument like a pencil, probably meant for a needle.

An attendant standing on the other side holds the patient's head. On the left side of the picture are—(1) a coat of arms, viz. a griffin rampant, impaling a cross ermine, with crest of a demi-griffin, and motto, "Dum Spiro Spero," and (2) below it, small pictures of a curved knife, a saw, and a long boot.

On the right side of the picture are—(1) a sun with human face and rays, and below it, (2) some curious surgical instruments. The above coat of arms bears some resemblance to that of Read, of Llandinan, Co. Montgomery.

The wording of the advertisement is as follows :

"These are to give notice, that William Read, Oculist and Chirurgical Operator, being invited by some persons

* Sir Edward Hannes, Knt., ob. 1710, M.D.Oxon., 1695.
† Ralph, 1st Duke of Montague.

of considerable Quality (who hath been well satisfied of several eminent cures he hath lately performed in the University of Oxford, and this last summer at Windsor) hath encouraged them to send for him, to perform some considerable cures here in Town, as couching of cataracts and curing of cancers, which he frequently performs without cutting, and likewise at Scrophulous Humours, or King's Evil, etc., as many Hundreds in England, Scotland and Ireland can sufficiently demonstrate. He hath been thrice in the University and City of Oxford, where he hath restored Blind people to their sight by couching, who continue to see very well, which is an operation many pretend to but few perform. He hath a Testimonial from the Vice-Chancellor, for several considerable cures he hath performed in the aforesaid University of Oxford, as upon your further perusal of this Bill you will find, which is a confirmation that he is none of those many Circumforaneus Pretenders that infest this Kingdom: He gives his advice freely, and cures all those that are really poor, of Blindness, Cancers, Wens, Hare-lips, or Wry-necks, gratis, and all others according to his ability, if they come or send to his lodgings while he stays in this Town, which will be for some part of this winter. He hath excellent and approved Remedies to preserve and strengthen the Sight in Young and Old, and to restore hearing, if curable. He likewise infallibly cures all Pains in the Head, that very often occasion the Gutta Serena or Black Cataract, which are never cured, but means may be used in time that may prevent these Obstructions in the Optick Nerves that occasion them. You may have faithful advice of him whether your distempers are curable or not. Out of many cures he hath lately Performed he will only mention these Few, couch'd by him at Oxford in 1689. And at his second coming in 1693. viz. Mrs Souch, Mrs Hall, Mrs Bishop, Mrs Sherlock, Mrs Sawyer, Mrs Simms, Mrs Kerby, Mrs Day, Mrs Faulkner, Mrs Bostel, Thomas Alcock, Thomas Cliff, Margaret Gale, and many poor People gratis: all restored to their sight.

"Captain Cook of Cirencester restor'd by him to his perfect sight although almost Fourscore years of age; and many more in the same countrey.

"Hannah Ayres and Alice Ayres, both of the Parish of Denton near Ailesbury in Buckinghamshire, were restored to their sight by him although Blind from their cradles. Madame Strickland of the same Town, who was Blind, was likewise restored to her sight by couching; performed in the year 1693–4.

"Windsor, April, 1694. He couched Mr Reeves, a gentleman of considerable quality, and restored him to his perfect sight, although Fourscore Years of age: and several others at the same time and Place.

"He also Perform'd a very considerable cure, by cutting out a Cancer, which weighed ten pounds, from the Breast of Mrs Cary, wife to Mr Ralph Cary, who was servant to King Charles the Second and now liveth at the Blew-Posts in Windsor: This was Perform'd and the Breast preserv'd in its proper shape, by the application of his much approved Styptick-Water, which no man in Christendome truly prepares but himself, although counterfeited by several Ignorant Pretenders that know nothing of the Preparation of it.

"Windsor, May 10, 1694. In the Presence of several Persons of Quality, he cut and cured Mrs Mary Glover, the Minister's daughter of Burnham, of a Wry-Neck, contracted down to her Shoulder. And a monstrous Double Hare-Lip for Thomas Goddard of the same Parish.

"May 16th, 1694. He couch'd the daughter of Mr John Hanson, Register of Eaton Colledge near Windsor, who was born Blind, and brought her to see very well in a few minutes.

"July 14th, 1694. He cut off a mortified Legg from Mrs Ann Crook at Windsor, which was perform'd in half a minute without the loss of an Ounce of Blood after the Styptick-Water was applied; in the Presence of his Grace the Duke of Northumberland.

"A Cataract couched by him for the daughter of Mr

Johnson at Grundon in Northamptonshire, who was Born Blind, and Restored to her perfect sight; and 20 more in the same countrey in 1687.

"John Davenore near Rippon in Yorkshire, although Born Blind, was couched by him, and restored to his perfect sight: and near 100 more in the North of England in the Year 1687 and 1688.

"Mrs Joice Wildah of Bath was cured by him in 1693 of a Tympany and Dropsey, when her Belly was as big as a Woman's with Two Children, and he made a perfect cure of it in six weeks without tapping.

"A Throat Rupture of a great bigness was cured by him for a Person of considerable Quality in this City.

"John Moor of Ogborne near Marlborough in Wiltshire had a large Wen cut off by him from his Belly, which weighed 24 Pound, and he perfectly cured him.

"Mrs Whiting near Market-Laventon he cur'd in the year 1693 of a dangerous cancerated Breast without cutting. She was Recommended to him by the Right Honourable the Earl of Abingdon, when left off by all others.

"He cut off a very large Cancerated Breast from the Body of Elizabeth Hopkins of Oxford in 1689, and perfectly cured her: for that and many other considerable cures he hath a Testimonial from the Vice-Chancellor.

"A French Gentleman belonging to Collonel Cornwal had his skull Trepanned which was dangerously Fractur'd by a Fall from a Horse, and was cured by him at Bath in May, 1693.

"He cur'd the wife of John Web of Wooten-Basset in Wiltshire of a Dead Palsie and Convulsion in the Nerves after being eleven years Bed-ridden, and restor'd her to the perfect use of her limbs.

"A Wry-Neck contracted down to the Shoulder, cut and cured by him in three days for the daughter of Mrs Cooper at Frome in Somersetshire.

"A large deformity of a double Hare-Lip cut and cured by him in five days for the son of Mr John Tower, a Merchant of Watchet in Somersetshire.

"A Gentleman near Guilford in Surrey was cur'd by him of a very dangerous Leprosie. And a child of Mr John Bartlet the Oxford-Carrier of the same distemper and both remain in perfect health.

"A Polipus in both nostrils, which is an excrescence of Flesh that proceeds from the Brain, was extracted from Mrs Smith at Barnstaple in Devonshire in the year 1692, and cured by him in three days.

"He is to be spoken with at Mr Agutters a Musical Instrument-Maker at the Sign of the Crown over-against York Buildings in the Strand, from 8 in the morning till 6 in the evening, where you will see a Bill of Operations hang at the door."

A few more references may be inserted here about Sir William Read.

From Le Neve's *Pedigrees of the Knights* (Harleian Society, vol. viii, p. 490) we learn the following: "Read, William, Her Majesties Occulist in Ordinary, Knighted at Windsor Castle, 27 of July, 1705 as a mark of her Royall favour for his great services done in curing great numbers of seamen and soldiers of Blindness gratis as the Gazette said. Mem. He was a mountebank formerly a servant to Penteus, he was a barbour at Ashdon in Essex, had no right to arms but bore by usurpation the com'n coat of Read—Azure a Griffon segreant.

"Read of Halesworth in Suff. Showmaker = dau'r of ———. Liveing at Halesworth, 1705 and mentioned by her son.

" *Fee paid.*

"Sir William Read, Knighted as above, liveing in Durham Yard, the Oculist. Dyed at Rochester. = 2nd wife, . . . dau'r of . . ."

From Le Neve's *Monumenta Anglicana* (vol. 1700–1715) we get as follows: "Obituary of several eminent persons deceased 1715, whose Inscriptions (if any yet set up) are not come to hand.

"Sir William Read Knt. Oculist to his Majesty died at

Rochester, May 24, 1715, buried the next day in St Nicholas Church in that City."

From the *Historical Register*, 1714–16, "Chronological Diary," p. 60.

"May 22. About the same time dy'd Sir William Read, his Majesty's Oculist in Ordinary.

"June 24. Mr. Roger Grant sworn Oculist in Ordinary to his Majesty in the Room of Sir William Read deceased."

Somerset House; Prerogative Court of Canterbury; Wills, etc.: Sir William Read left no will, but his goods were administered by his widow Augustina, Lady Read. The following is the extract: "Dus Willmus Read septimo die (Julii 1715) commissio Dominae Augustinae Read, Relictae Domini Willielmi Read Militis nuper parochiae s̄ti Martini in campis in com Midxie decessi, licentia etc ad administranda bona et credita dicti decessi bene etc." There is no record of any will or administration of his widow, down to 1760 inclusive. The administration act does not show the amount at which his estate was sworn; at this date it rarely does so.

In order to find some reference to Sir William Read's appointment as oculist to Queen Anne, the officials at the Public Record Office recommended a search through several MSS., and those for some years were searched without effect.

The "State Papers, Domestic Series," have been calendared for that period, and one volume of Queen Anne's reign has been printed, but neither in printed nor in MS. volumes down to 1716 does there appear to be any mention of Sir William Read. His salary, if any, is probably given in some book of accounts, but the officials could not point out where it was most likely to be found. The "State Papers, Domestic," contain large numbers of appointments to offices in the Royal Household, but apparently not this particular one.

Musgrave's *Obituary* mentions the death of Sir William Read as from 19–22 May, 1715, but Le Neve (see *supra*) says clearly that he died on May 24. In view of the

extract sent me by the sexton of the cemetery where his body was buried, from the parish register, it seems that Musgrave is more likely to be correct than Le Neve.

In his advertisement he used what Le Neve speaks of as the common coat of Read; this was used by a family of Read of Llandinam, Co. Montgomery, and it is also shown in Berry's Kent pedigrees, with a pedigree of about five generations coming down to 1680, or thereabouts. In this pedigree there were two brothers Read, of London, one of whom, who died in 1657, had a son William, but this does not agree at all with Le Neve's pedigree. Berry does not give the name of the place in Kent where these Reads lived. The fact that Sir William died at Rochester makes it just possible that he had a Kent connection, but in view of the migratory habits of quacks at this and indeed at all times, it is more likely that he was touring the provinces when death overtook him.

This seems to be all that can now be discovered about Sir William Read; the fact that he died intestate robs the searcher of one of the most fruitful sources of information, *i. e.* his will. His book can hardly be regarded as a serious contribution to medical literature, but it is in parts quaintly worded and so amusing. There are, as might be expected, numerous references to the marvellous cures effected by the author, and a strong recommendation to use his noted eye-water and his equally famous styptick water. He deprecates the custom of "drinking in the morning for the eye-sight" although by so doing a certain Southwark brewer recovered his sight, but "much moistening the brain by drinking is pernicious to the eyes."

An old friend of mine, Dr. John Aylen, who is in practice at Halesworth, kindly had the parish registers searched for me. The early registers are missing, and the present volumes date from 1653, and contain no notice of Sir William Read.

9. *A note on the centre of rotation of the eye.*

By H. Grimsdale.

The problem to which I want to call attention is that of the mechanism of the stability of the eye. We are accustomed to observe every day the changes of position of the eye due to the action of the external muscles, but we comparatively rarely think of the mechanism by which the eye is maintained in its primary position, and how the centre of rotation is almost, if not absolutely, fixed. That it is an advantage to the animal, from the point of view of orientation in space, to have the centre of rotation at least approximately fixed, is sufficiently obvious. We know how the angular deviation of the eye gives an indication of position; how a defect in the angular rotation, as in paresis of a muscle, causes faulty projection; we know also how enophthalmos or exophthalmos interferes with the ocular movements. Unless, then, the centre of rotation were approximately fixed for any degree of rotation the faculty of orientation would be acquired with more difficulty, and would probably be less complete.

It is this requisite, I think, which has led to the acquirement of a fixed position for the centre of rotation in almost all vertebrates. The only exception to the rule of which I am aware is the condition of some of the flat-fishes, who have a reservoir of fluid outside the orbit covered by a sheet of muscle, and connected with a second reservoir behind the eye. By contraction of the muscular sheet fluid is forced from the first into the second reservoir, and the eye is made more prominent; and the reason for this is not far to seek.

The flat-fish lies on or often in the sand or mud at the bottom of a shallow sea or estuary. His field of vision, if the eye is on a level with the mud, is very limited; by protruding the eye, even to a small extent, he is able to look over a much larger area—the prominent eye acts, in fact, as a periscope.

In some fishes, *e. g.* the sharks, we find a mechanism to prevent enophthalmos in the shape of a strong cartilaginous bar, which, springing from the interorbital septum, forms a strut to support the eye, and incidentally gives origin to some of the ocular muscles. This bar must tend to resist the pressure of the water when the shark dives deeply—a pressure which would reduce the bulk of the loose tissue of the orbit, and thus cause enophthalmos.

In mammals, who live in a medium with only small variations of pressure, and who have their eyes directed forwards at a considerable elevation above the ground, neither of these mechanisms are necessary; protrusion of the eye would give no appreciable alteration of the visual field, and the variations of atmospheric pressure are never enough to require a special support; therefore we find no trace of them. But there is, on the other hand, in many mammals, a muscle developed round the optic nerve, attached in front to the sclerotic, and behind to the ligamentous ring round the optic foramen—the choanal muscle, which seems as if it were devised to resist a possible protrusion of the eye. This is specially developed in the large ruminants, who habitually carry their heads low, and use them for weapons of offence and defence.

In the majority of mammals, and among these, man, there is usually no development of the choanal muscle, which is found only as an abnormality, but even in these the anatomical disposition of the external muscles is such that any tonic contraction of these muscles which may exist must tend to pull the eye as a whole backward and inwards.

It may be objected here that the whole subject of "tone" is a difficult and doubtful one; that we do not know that there is any constant tonic contraction of the resting ocular muscle; and that, therefore, I have no right to assume and talk about forces whose existence I cannot prove. But if we consider the rapid movement and accurate adjustment of the work of the ocular muscles, it must seem most probable that the muscle is, as it were,

continually on the alert, ready to spring into action at once, and no time is wasted in taking up the slack of an entirely relaxed muscle before movement begins. Further, since the eye is by hypothesis at rest, we may assume without danger that the tone of each member of the various opposing pairs is equal to that of its partner, and—I admit there is little justification for this—it is convenient to assume that the "tone" of all the muscles is equal. This being granted, we must have the resultant of the "tone" of the two pairs of the recti muscles pulling the eye backwards and inwards in the line joining the centre of rotation to the optic foramen, with a force—taking that of one muscle as unity—equivalent to about 3·5. The resultant of the obliques must pull the eye forwards and inwards.

The final resultant of the combination of these two forces must be directed inwards—whether forwards and inwards, directly inwards, or backwards and inwards is immaterial to the immediate point; but if we assume that the "tonic force" of all the muscles is equal—and I repeat that this assumption, though convenient for calculation, has little or no justification—then the final resultant will be represented by a force of about 3·75, acting backwards and inwards along a line at an angle of about 40° from the sagittal plane.

It is this backwards and inwards pull—which has attracted little attention of anatomo-physiologists in the past—that I call to your notice now.

If we grant the existence of this pull, there must be something to resist it—some force directed forwards and outwards.

If we can find anything which causes such a pressure, we shall have gone a long way towards solving the problem of the stability of the eye.

But before we attack the problem, there are a few preliminary points with which I wish to deal, so that we may see clearly the structures which are concerned.

Rotation of the Eye.

It is usually said that the eye forms a perfect example of a ball-and-socket joint—that the fat and Tenon's capsule form a fixed socket in which the eye turns. It is curious that this superficial resemblance should have made anatomists blind to the obvious impossibility of the supposition. It is no new discovery that the analogy is wrong: Motais more than twenty years ago called attention to it, but the faulty description is still current.

There are three considerations which occur immediately to one as sufficient to contradict the supposition:

(1) There is no "slack" of Tenon's capsule at the junction of capsule and globe to allow the movement without disturbing the posterior part. In all ball-and-socket joints the capsule uniting the two elements is so lax that it allows free separation of the two when the surrounding muscles are divided.

(2) If the posterior part of the capsule is fixed, the length of optic nerve within the space of Tenon must vary with the position of rotation, and the nerve must move up and down in the sheath like a piston in a cylinder.

(3) In those mammals who have a choanal muscle rotation cannot happen.

It is certain, then, that the fat does not form a cup, lined by Tenon's capsule, in which the eye turns; the capsule and the adjacent structures must move largely with the eye.

The simplest description of the fasciæ of the orbit is to be found in the French *Cyclopédie d'Ophtalmologie*; it is written by Motais, and in so far as I can judge is accurate. The difficulty of obtaining material for research has prevented me from making any new examination, but the dissected specimens in the Museum of the College of Surgeons, which are by no means sufficient for the purpose, so far as they go, bear out his work.

In his view the fascial sheaths of the muscles may be taken as the starting-point of the description; at each

edge of a muscle the two layers come together and pass over the inter-muscular fat to the edge of the next muscle, where they again separate to enclose it.

At about the equator of the globe the two layers of fascia finally part company, the superficial passing on to form the anterior half of the capsule of Tenon, and the deep turning at an angle over the front of the intra-muscular fat-cone, to form the posterior section of the capsule.

A little further forward the superficial layer splits and sends a funnel-shaped prolongation forward, to be attached round the margin of the bony orbit. In this funnel-shaped fascia certain parts are developed more strongly to form the check ligaments of the muscles, and of these the external is by far the most strong. These check ligaments may help to resist the backward pull, but it is an axiom of anatomists that no ligament alone can resist constantly any muscular action.

The vascular orbital fat fills up the greater part of the orbit; it is not evenly distributed; a thicker pad intervenes between the eye and the inner wall than between the eye and the outer wall of the orbit, and a thicker pad is present below the eyeball than above. It is not found to vary much in amount; the fat man does not deposit much excess of fat in the orbit, nor does the thin man suffer from a deficit; the orbital fat does not share equally with the rest of the fat in the decrease during starvation: the hollow-eyed look of hunger probably depends as much on a diminution of the quantity of blood as on a removal of fat. In this persistence the orbital fat behaves like the fat generally when connected with nervous tissue. It is true that Foster Moore has recently described a sudden increase of bulk in the fat of the orbit in exophthalmic goitre, but it seems more reasonable to view this as an increase of bulk simply, due to some angio-neurotic œdema rather than to a true increase of the fat.

We know that under certain conditions alteration of the vascular state alone can alter the prominence of the

eye. Thus, after death, the eyes are usually sunken as the vessels of the orbit empty; but it is stated that after death by strangulation the eyes are prominent, and this must be due to retention of blood in the orbit.

Again, in arterio-venous aneurysm of the orbit, the increase of pressure in the veins brings about great prominence of the eye. In some rare cases, where the vessels of the orbit are changed into large sinuses, very slight alterations of pressure bring about alternations of ex- and enophthalmos as the vessels are filled or empty.

We have seen, too, that in Ungulates the choanal muscle is well developed, and this serves to prevent the proptosis of the eye when the animal makes a great effort with its head low, *i. e.* when the venous pressure in the orbit is raised considerably. Even in man, who has no choanal muscle, when a strong muscular effort is made with fixed thorax, a contraction of the orbicularis palpebrarum often may be seen, and this can have no object but to resist the proptosis of the eye.

When the pressure in the veins rises, following obstruction to the return of the blood, through muscular effort or external compression or what not, there tends to be protrusion of the eye.

It follows, then, that the force which opposes the tonic pull of the recti muscles is exerted by the heart-muscle and is transmitted to the vessels of the orbit. It is the action of the heart, in combination with the state of the vessels, which determines the relative prominence of the eye.

10. *A detachable arm for converting the stand of the direct record scotometer into a full field portable perimeter.*

By N. Bishop Harman.

We do not often need to carry a perimeter wherewith to examine a patient who cannot visit us, but this need

does arise on occasions. Then the cumbersomeness of any sufficiently large instrument makes its presence felt inconveniently. There are some portable instruments, but most are on such a small scale that their value is greatly diminished. There is a larger model, I believe the device of Mr. Brudenell Carter, but it is costly. It occurred to me to attach a quadrant arm to the stand of the scotometer which I recently showed to the Royal Society of Medicine. Messrs. Weiss have carried out the suggestion in excellent fashion. An aluminium arm curved on the edge is fitted to a brass pivot, which in turn is attached to a slide socket. The socket fits on to the upright of the scotometer stand, just as the screen of the scotometer does. Fitting is instantaneous; there are no screws or bolts to attach, and it is removed with the same expedition. There is a disc that slides on the brass pivot graduated in the degrees indicating the position of the perimeter arc, and the arc itself is graduated for the circles. The arc is so light that there is no need of counterpoise. The object-holder is a long slender rod; at one end is fitted a block of wood; on two opposing faces are attached white and red object-cards, each 15 mm. square; on other opposing faces the objects are 10 mm. square, and on the face of the block is a 5 mm. white square. At the other end of the rod is fitted a pencil-holder, so that as the object is slid along the curve of the perimeter arc and the readings obtained a movement of the hand brings the pencil on to the chart to make a record of the observation. The whole apparatus weighs only some 8 oz., so that it adds very little to the weight of the scotometer; it fits into the same scotometer "attaché" case without alteration.

11. *Estimation of torsion on near vision.*

By G. F. Alexander.

Ocular torsion with the visual axes parallel can be demonstrated and estimated by Stevens' clinoscope; but

on near vision by the use of a vertical prism or Maddox double prism, though it can be demonstrated it cannot be estimated, and I think I am correct in saying that no satisfactory method of its estimation has hitherto been forthcoming, the application of Dr. Stevens' principle to near vision being difficult and the instrument a costly one.

The projection of the image of a horizontal line on a card after being displaced in one eye vertically by a prism becomes in the presence of torsion inclined to the line as seen by the other eye: but hitherto it has not been possible to estimate the angle of their inclination, and if the projection be over a series of parallel horizontal lines as on the card shown the same might be thought to apply to the reduplication of this angle: but in the latter case the estimation becomes extremely easy from the following consideration, viz. as the tangent of an angle of $1^{\circ} = \cdot 0175$ and this $\times$ 100 = 1·75, if the upper line is 100 mm. in length and the lower lines are 1·75 mm. apart, if one end of the former when displaced by a vertical prism coincides with one of the latter, each space covered by its other end corresponds to 1° of torsion.

A prism of prismatic angle 10° is placed pointing down in front of the right eye, when if the right end of the displaced upper line is the higher we have ex-torsion and if this end is the lower we have in-torsion.

In exophoria at the near distance the card is adjusted to the distance which brings the higher end of the displaced upper line to coincide with the top line of the series, when the number of spaces and fraction of a space covered by its lower end expresses in degrees the angle of torsion at about the reading distance, and similarly in esophoria this angle is obtained by adjusting the card to the distance which brings the lower end of the displaced upper line to coincide with the bottom line of the series; if the lateral deviation throws the displaced upper line at all off the series it must be brought within its limits by a horizontal prism.

The presbyopic correction of the subject must be worn.

The cards are made by Messrs. Curry & Paxton, and it is hoped that by their use we may arrive at the normal torsional angle; in my own case it varies between $1\frac{1}{2}^{\circ}$ and $2\frac{1}{2}^{\circ}$, averaging 2°.

XI. APPENDIX.

The following were also brought before the Society :

(1) Mr. W. G. Howarth : A specimen showing hæmorrhage into a pituitary cyst following operation by the intra-nasal route.

(2) Mr. Percy Sargent : A specimen of suprapituitary tumour.

(3) Lieut.-Col. H. Herbert : Cases demonstrating the iris-prolapse operation for glaucoma.

(4) Mr. R. Affleck Greeves : A case of unilateral proptosis.

(5) Mr. Basil Graves : A demonstration of the contact-illumination method.

(6) Mr. Maitland Ramsay : Barraquer's erisiphake.

(7) Sir William Lister : Two cases showing holes in the hyaloid membrane of the vitreous.

(8) Mr. A. S. Percival : Rotating discs for estimation of changes in the light-sense.

(9) Messrs. Barr and Stroud : The optophone.

REPORT OF COUNCIL.

The Council is glad to be able to report the continued prosperity of the Society. We have a total of 482 subscribing and 5 honorary members. During the Session 1920–21, 19 new members have been elected, there have been five resignations, four members many years in arrears with their subscriptions have been deleted from the list of members, and we have to deplore the death of four members. Mr. Charles Higgens was an original member of the Society and an original member of the Council. His death leaves Mr. Waren Tay and Sir Thomas Barlow the sole survivors of the original Committee of the Society. Mr. Henry Edward Juler was also an original member; he served on the Council 1886–89, and was Vice-President 1900–02. Dr. Russell Thomas had been a member since 1903, and Dr. T. H. Delany since 1918.

The resolutions passed at the last Congress, two in number, were duly forwarded to the various bodies authorised, and with regard to teaching of ophthalmology, the General Medical Council sent a copy of their minute of May 31st, 1919:

"That every student should be required to attend a course of practical instruction in ophthalmology of not less than ten weeks' duration, and that no student should be admitted to the Final Examination unless he presents a certificate to the effect that he has attended such a course regularly, and that his work in connection therewith has reached a satisfactory standard."

Copies of the resolution passed with regard to practical instruction in the history and treatment of ophthalmia neonatorum, the Metropolitan Asylums Board having

decided to allow St. Margaret's Hospital to be used, with certain safeguards, for the purpose, were sent to the following bodies: The General Medical Council, the Registrars of the Universities of Oxford, Cambridge and London, the Central Midwives' Board, the Examining Board in England of the Royal College of Surgeons and the Royal College of Physicians, and the Society of Apothecaries. With the exception of the Registrar of the University of Cambridge, all these bodies sent official acknowledgments, and the University of London and the Central Midwives' Board have passed resolutions on the subject; the former, considering that the question is covered by the regulations for the third M.B., have decided to take no action in the matter; the latter thank the Society for its resolution, and express the hope that advantage will be taken of the facilities offered by the Metropolitan Asylums Board for the holding of classes in connection with the treatment of ophthalmia neonatorum.

The Eighth Annual Congress of the Society was held at the Royal Society of Medicine, 1, Wimpole Street, on April 29th, 30th, and May 1st, 1920. The meetings were largely attended, and proved successful in every way. The clinical meeting was held at the Royal London Ophthalmic Hospital, where Mr. Percy Flemming kindly gave a lecture with lantern-slides on the history of the district.

During the past year the Scottish Ophthalmic Club has been affiliated to the Society.

The Treasurer's Report and statement of accounts is appended.

HON. TREASURER'S REPORT.

The financial condition of the Society may be considered satisfactory. At the close of the financial year (March 31st) we had a credit balance at the bank of £44 9*s*. 6*d*. By energetic dunning I have succeeded in collecting a good deal of subscriptions in arrears, amounting in all to £62. There still remain about £220, a good deal of which I may still hope will eventually come into the bank. Quite a number of members had not paid their current subscriptions when the accounts were closed for audit, and as a consequence there are many who have not yet received their copies of the *Transactions*. This appears to be a source of grievance to some, and I should like to emphasise the point that members who have not paid their subscriptions are not entitled to the *Transactions* until they have done so. Yet once again I would call attention to the value of a banker's order. I adopted this year the scheme of sending out a banker's order in every case in which a reminder of unpaid subscription was necessary, but the invitation has not been met with an encouraging response. Why will so many members continue to put themselves to so much inconvenience and the Treasurer's department to so much trouble and unnecessary expense? One minute's trouble in the filling up of the order and for the rest of life there is no more bother, and the *Transactions* arrive automatically as soon as published.

The very heavy bill for the *Transactions* and sundry printing, which is £310 7*s*. 6*d*. in excess of that paid last year, is very largely due to the expense of compiling the General Index for the last ten years. I am sorry to say

this item reached the very large total of £230. It could not be helped, and luckily it is an account with which we shall not again have to reckon until 1930. I think you will all agree that the work has been done in an extremely able manner, and that the minute and careful cross-indexing will prove of great value. Deducting the amount paid for the Index, we see that the *Transactions* bill was £80 7*s*. 6*d*. in excess of last year's account. The Oxford Ophthalmological Congress contributed £48 19*s*. 7*d*. as against £16 last year, so that the actual increase of expense of the *Transactions* this year was about £60. As this year's *Transactions*, without reckoning the General Index, contains 42 more pages than its predecessor, it will be seen that the actual rise in cost is inconsiderable. It is to be hoped that we have now reached the high-water mark of expense in this direction. In order to meet this bill it was necessary to sacrifice our nest-egg in the shape of the £150 which was on deposit at the Bank; but this loss has been largely discounted by a most gratifying increase in the amount received by sale of the *Transactions*, which this year brought a sum of £104 1*s*. 4*d*. as against £39 1*s*. 4*d*.—the total of last year's sale—being an increase of £65. The net loss to the Society entailed by the sacrifice of the £150 therefore amounts to £85. I see no reason why we should not continue in the future to obtain as much revenue by sales as we have done this year, and, if so, it will go a long way towards the payment of producing the *Transactions*.

The "Illustrations Fund" has been something of a disappointment, not only in the actual amount of subscriptions, but more especially in the very poor individual response. I am given to understand that certain members object to this fund "on principle," by which I mean that they consider that if a burden is to be laid on the Society that it should be one that is shouldered by one and all alike. I would remind such members that it was this very feeling that some could help much more easily than others that brought about the existence of this fund. It

arose in order to allow the less wealthy as well as the more prosperous members to have their contributions fully illustrated without a request for private contribution to the expense, and it is essentially a means by which those better equipped financially can help their poorer colleagues, especially the junior members of the Society. I think the senior members of the Ophthalmological Society ought, all of them, to come forward to give something to this fund in the spirit of Bowman, who, for several years in the early days of the Society, subscribed annually a sum of £90 to put the Society on a sound financial basis.

In accordance with the wish of the Council and with the approval of the Trustees I have invested £450 of the subscriptions in 4 per cent. Funding Loan, which will produce an annual income of £25. If the fund can be increased to produce an annual income of about £70 we may, I think, be satisfied, and I have much hope that ere long I shall be able to announce that the fund has reached the necessary figure to produce that income.

Lastly, I would draw attention to the fact that a guinea and a half seems to present an insuperable arithmetical problem to quite a number of members. Seeing that as a body we habitually deal in the elusive guinea, it is the more surprising that one and a half guineas is so frequently represented by a cheque for thirty shillings. I am afraid that the mistake most commonly occurs among the Oriental members of the Society, and I hope that these remarks will help to lessen the number of applications for eighteenpence, which invariably means that the Society in the end only nets a shilling and stands to lose the remaining sixpence in postage and stationery.

ARNOLD LAWSON.

ACCOUNT OF THE RECEIPTS AND PAYMENTS
OF THE
OPHTHALMOLOGICAL SOCIETY OF THE UNITED KINGDOM,
FOR THE YEAR ENDING MARCH, 1921.

Receipts						
1920-21.	£	s.	d.	£	s.	d.
To Balance from last account:						
Deposit	150	0	0			
Bank	32	5	3			
				182	5	3
„ Subscriptions:						
Per Bank	287	12	0			
„ Collector	219	16	10			
	507	8	10			
Less Subscription returned	2	12	6			
				504	16	4
„ Dividends:						
East India Stock (half year only)	7	0	7			
Ramsgate Corporation	15	6	0			
London County Council (Nettleship Prize Fund)	9	0	0			
				31	6	7
„ Oxford Ophthalmological Congress				48	19	7
„ Returned Income Tax				11	18	8
„ Sale of 'Transactions'				104	1	4
„ Contribution towards Illustration Mr. A. H. Thompson)				5	8	6
„ Deposit Interest				8	12	6
				£897	8	9

Payments.						
1920-21.	£	s.	d.	£	s.	d.
By Printing 'Transactions' and Index	669	15	7			
„ Illustrations	55	16	3			
„ Sundry Printing	31	15	2			
				757	7	0
„ Reporting				19	8	11
„ Royal Society of Medicine				8	15	4
„ Collector:						
Salary	21	0	0			
Postages, etc.	4	19	0			
				25	19	0
„ Petty Cash (Hon. Sec.)				2	12	6
„ Bank Charges				0	8	1
„ Miss Pollett				4	1	5
„ Mr. A. L. Clark for Index				34	7	0
„ Balance at Bank				44	9	6
				£897	8	9

Examined and compared with Pass Book, Vouchers and Receipts, and found correct.

(*Signed*) M. W. B. Oliver, M. H. Whiting } *Hon. Auditors.*

March 22nd, 1921

ILLUSTRATIONS ACCOUNTS.

	£	s.	d.
To Donations	479	9	5
„ Interest on Deposit	7	15	9
	£487	5	2

	£	s.	d.
By Amount placed on Deposit	435	0	0
„ Balance at Bank	52	5	2
	£487	5	2

Examined and compared with Pass Book, Vouchers and Receipts, and found correct.

March 22nd, 1921

(*Signed*) M. W. B. OLIVER } *Hon.*
M. H. WHITING } *Auditors.*

List of Subscribers to July 1st, 1921.

	£	s.	d.
P. H. Adams	5	0	0
A. J. Ballantyne	2	2	0
A. R. Bradley	3	3	0
T. Harrison Butler	5	5	0
Ernest Clarke	21	0	0
J. Gray Clegg	21	0	0
E. Treacher Collins	100	0	0
Sir Anderson Critchett	5	0	0
R. E. Cruise	10	10	0
H. H. Cunningham	1	1	0
J. Jameson Evans	2	2	0
J. Herbert Fisher	21	0	0
Harold Grimsdale	2	0	0
George Harston	5	5	0
J. S. Hinnell	2	2	0
Gordon Holmes	3	3	0
Robert Jaques	1	1	0
E. E. James	10	10	0
James W. Jellett	1	1	0
F. A. Juler	5	5	0
Arnold Knapp	5	1	11
Wm. Lang	5	5	0
Sir Arnold Lawson	15	15	0
Harold Levy	2	2	0
W. J. Lindsay	0	19	6
Sir W. T. Lister	100	0	0
H. Willoughby Lyle	2	2	0
Arthur F. MacCallan	1	0	0
Angus MacGillivray	5	5	0
George Mackay	10	10	0
W. H. McMullen	2	2	0
E. E. Maddox	2	2	0
J. Cole Marshall	2	2	0
Miss E. M. Maxwell	1	1	0
M. S. Mayou	10	0	0
J. Chamber Mead	2	2	0
H. C. Mooney	2	2	0
H. Neame	1	1	0
J. Herbert Parsons	15	15	0
Leslie Paton	5	0	0
R. Packard	10	10	0
W. B. Inglis Pollock	2	2	0
H. E. Quick	2	2	0
Maitland Ramsay	10	0	0
Austin Reynolds	1	1	0
A. B. Roxburgh	10	0	0
A. H. H. Sinclair	2	2	0
W. W. Sinclair	2	2	0
T. Snowball	5	5	0
J. Barbour Stewart	2	2	0
John B. Story	10	10	0
Henry H. Taylor	1	1	0
James Taylor	3	3	0
T. H. D. Townsend	2	2	0
H. M. Traquair	5	0	0
C. H. Usher	5	5	0
Cyril H. Walker	10	10	0
J. D. Wardale	5	5	0
John Wharton	5	5	0
A. L. Whitehead	5	5	0
T. Whittington	1	1	0

OXFORD OPHTHALMOLOGICAL CONGRESS. 1921.

ANNUAL MEETING HELD AT OXFORD ON JULY 7TH, 8TH & 9TH.

Master: SYDNEY STEPHENSON.

Past Master: The late R. W. DOYNE.

Deputy Master: P. H. ADAMS.

Hon. Treasurer: Sir ANDERSON CRITCHETT, Bart., K.C.V.O.

Hon. Secretary: BERNARD CRIDLAND.

REPORTS.

1. *Discussion on the causes of infection after the extraction of senile cataract.*

Dr. V. MORAX (Paris):

OCULAR surgery has largely profited by the progress realised in general surgical technique, especially in the sterilisation of instruments, washing solutions, collyria and dressings. We can postulate that everyone anxious to operate in the safest conditions will have the possibility, if he will only pay attention, of executing an ocular operation without any infectious germs which his instruments, liquids or hands might convey, or which his mouth might send out. But will this be sufficient to protect against every kind of operative infection? Experience unfortunately shows us that, even in these conditions, ocular infection may develop either immediately

after operation or in the following fortnight. Infections which appear after the third or fourth day are called *late* infections.

First of all it seems to me necessary to insist upon the symptoms which allow us to say that infection exists. The evolution of the non-complicated ocular operative wound is well known. The painful phenomena which succeed the operation are variable, but when their cause is solely traumatic they cease after several hours.

The persistence of pain, its appearance or exaggeration after the first twelve hours, is nearly always the symptom which allows us to suppose there is an infectious complication. It will compel us to uncover the eye and examine the wound.

We shall sometimes have the agreeable surprise of seeing that all is normal, and attribute the pain to a nervous hyperæsthesia of our patient. But more often we shall discover an infiltration from the edges of the wound, an exudation in the anterior chamber and in the pupil, which forces us to admit that an infectious agent has penetrated the ocular tissues. In these conditions no doubt subsists in the mind of the operator: an infectious complication is taking place.

In other cases the ocular sensibility is less acute. There are some slight shooting pains, and when the eye is examined you will not find any great modifications in its tissues besides a sclero-conjunctival hyperæmia. Yet the eye is photophobic and watering. If you use a lens you will perceive on the edges of the pupil some exudation, some adhesions after the use of atropine.

Attentive examination sometimes shows some exudative precipitates. In certain cases a plastic exudation partially occupies the pupil, and constitutes with the posterior capsule or the *débris* of the lens a greyish membrane, which fills the pupillary field.

In such cases we call these iritis, iridocyclitis or plastic iritis. A good number of operators do not consider these cases of iritis or iridocyclitis as infectious

complications, and when they establish statistics they leave out such cases, considering that they are only traumatic reactions.

I cannot adhere to this conception, but I willingly recognise that the demonstration of the infectious nature of these cases has not yet been made: the infectious hypothesis does not rest upon direct demonstrations (as in cases in which we have grave suppuration of the globe), but only upon likelihood. Indeed, these slight complications have, like the grave ones, become rarer and rarer.

If it were a question of a traumatic lesion, their frequency would be the same for all operators; now, we find here also the marked influence of operative qualities (rigorous asepsis, lightness of hand, etc.).

Besides the traumatisms there has been incriminated the irritating action of lens-cells, which often persist in the pupillary field when the extraction is done as usual. Prof. Barraquer invokes this hypothesis in praising the capsular extraction by *phakoérisis*.

There is no doubt that the persistence of fragments of the lens in cases in which operative infection, even slight, takes place, aggravates the condition of this infection. But, by taking minute precautions to avoid operative infection, I can say that I have never seen cases in which I was able to convince myself of the existence of iritis or iridocyclitis provoked by the presence of a secondary cataract only.

In my opinion, if infection does not complicate the extraction of the lens, evolution will be simple, without pain or photophobia and without watering. The only complications which we could observe would be the result of bad coaptation of the wound (by pinching of the iris or the capsule), or of the co-existence of other affections, such as glaucoma.

Now let us look for the causes of operative infection. Three kinds of causes must be taken into consideration:

Firstly, that which directly commands the infective complications; I mean the infective micro-organisms.

Secondly, the *mediate* causes, which allow the infective agents to be in the conjunctiva and to penetrate the wound.

Thirdly, the *adjuvant* causes, which facilitate ocular infections.

It might seem more logical to study first the *mediate* causes, but I prefer to begin with the microbial causes.

I. Microbial Cause of Operative Infection.

Judging by the small number of bacteriological examinations of operative infections, we might believe that few operators have observed such accidents! However, nothing would be more useful than a systematic bacteriological study of all infective accidents complicating operations. I must recognise that these studies are not always easy. In the presence of this kind of complication the oculist must always hope that the infective process will stop, or be arrested by therapeutics. All new traumatism may aggravate the conditions, so we are led to "wait and see." Several days, several weeks will elapse before the pus is examined, and it may be that the microbe will have disappeared by the time the examination is made.

Another cause of error, not less frequent, comes from the fact that the microbial centre may be very limited. I have sometimes observed that, in spite of very apparent cellular exudation in the iris or ciliary body, the aqueous humour and the vitreous did not show microbes, whereas I found them on a point of the ciliary body. The fact that the growth on ordinary culture media obtained from liquid extracted from the eye does not give positive results, will not allow of the conclusion that an infective process is absent, nor even of the possibility of an infection produced by a non-culturable germ.

When the infective process has invaded the deep membranes and provoked panophthalmitis, the conditions of bacteriological examination are so simplified that the globe, which will surely become atrophied, is often excised

in order to suppress the painful after-effects. The globe may then be easily examined, after opening it with sterile scissors, and pus taken at the point of the most infiltrated part.

This explains to us that the published bacteriological examinations of operative infection nearly all concern globes deeply infected by agents of acute suppuration. In one case only, reported by Kuhnt, infection was limited to an edge of the wound, where it was circumscribed by treatment and panophthalmitis avoided.

Here are the statistics of cases of serious post-operative infections which I have been able to find in French, English, American and German papers, and to which I have added two private cases. Out of 35 cases, 21 times the pneumococcus was found guilty, staphylococcus 9 times, streptococcus twice. Three times there were badly determined microbes, which were attributed to the *subtilis* class. This shows us at once the important part played by the pneumococcus in post-operative infections, and yet I believe it gives us an incomplete impression of its importance; the pneumococcus is still more often guilty, and my opinion is founded both on the examination of a few post-operative infections and on the bacteriological findings in a much greater number of traumatic infections.

Bacteriological findings are necessarily much less often to be had in cases where the infection is of the *iridocyclitic* type and evolves no panophthalmia. Cases are, however, to be found in papers published by Elschnig and Ulbrich, Kuhnt, Hancock, Kraupa.

Pneumococcus was found twice; staphylococcus eight times; xerosis bacillus once; not further identified bacillus (Gram negative) once.

In Hancock's three cases the eye was taken out, and an anatomical examination showed that vitreous and chorio-retina were healthy, although clinically panophthalmia had been feared. The most important bacteriological study on this subject is that of Kraupa, who writes

on 22 cases of post-operative iritis and iridocyclitis out of 635 operations performed by Elschnig. In all of these 22 cases he punctured the anterior chamber. Seven times only did cultures give any results. In the other 15 cases, notwithstanding the existence of hypopyon, the cultures were sterile. Kraupa's conclusions show that an hypopyon does not always prove an infection to exist. He establishes a curious distinction between these 15 cases, where the hypopyon was sterile, considering as infectious complications those only where microbes were to be found on the conjunctiva, and not those where both the conjunctiva and the anterior chamber gave negative bacteriological findings. It is a known fact, however, that the hypopyon which follows pneumococcus keratitis is always sterile, but that in no way proves keratitis not to be an infection, as that microbe is to found abundantly on the edge of the ulcer. I have shown above how this can be a cause of error in the statistics of infectious complications. The study of these mild cases of infection should, therefore, still be pursued.

Let us now come back to the microbes found, and amongst these the pneumococcus comes first. The pneumococcus ought to be particularly well known by oculists, on account of the predominant part that that microbe plays in ophthalmological infections. A great number of authors have studied it, and I believe it necessary to report the results found in the latter years. These researches have especially dealt with its cultures, its virulence, the possibility of classing it in several separate groups and the making of an anti-pneumococcus serum.

Although the pneumococcus develops with ease in the human tissues, it does not grow well on all cultural media. It does not develop on gelatine; it requires strictly neutral media, and its growth is richer when human serum is added. This explains why the earlier bacteriologists very rarely found the pneumococcus on the unhealthy as well as the healthy conjunctiva, gelatine or ordinary agar being used. Elschnig and Ulbrich added

human serum, and found the pneumococcus to exist on 30 per cent. of normal conjunctivæ. Imre found 38 per cent. positive cases, whereas preceding observers, as Hernersdorff or Oertzen, gave only 5 and 4 per cent. This shows the importance of using culture media with human serum when one looks for the presence of the pneumococcus.

Truche, Cramer and Cotoni have been using with as good results a new medium very simple to prepare, composed of peptone water, to which a small quantity of glucose is added :

Water	100
Peptone chapoteaux . . .	4 g.
Glucose	0·20
Salt (NaCl)	0·50

This solution must be slightly alkalised.

Truche and Cotoni have also shown the possibility of keeping a race of pneumococci virulent for several months by mixing two parts of gelatine with one of a twenty-four-hour culture of such a medium. The glass is sealed and kept in the ice-box.

This leads us to study the virulence of different samples of pneumococcus. It is very variable, and we have no tests to judge of the virulence for man of a given sample. Certain animals—mice and rabbits, for instance—are very easily killed, but one cannot judge of the virulence for man from the results of experiments on these animals. Pneumococcus can be taken from a normal conjunctiva and be very virulent for a mouse, whereas no virulence is found in other cases where the pneumococcus comes from an acute conjunctivitis.

Truche and Cotoni have shown us that when a sample is very virulent for a mouse it remains so almost indefinitely, but only when kept in favourable conditions, such as we have given above, or by continuous passages through the mouse. When no such precautions are taken cultures very rapidly lose their virulence, and we can easily understand the great variability of virulence of the

pneumococcus on the human conjunctiva. Evidence of its variability is given by the outbreak of epidemics of pneumococcus conjunctivitis at certain times of the year, whereas at other times such complications are rare, and still the pneumococcus is to be found on the healthy conjunctiva in such proportions as those we have reported above.

It is often found difficult to separate the pneumococcus from the streptococcus, and certain authors (Elschnig, for instance) simply speak of "Kettenmicrococcus," which covers both the pneumo- and the streptococcus. Several means of diagnosis between these two have lately been devised. The streptococcus is more often hæmolytic than the pneumococcus, and it is advisable to add a few drops of blood to the bouillon culture, which shows the hæmolysis after twenty-four hours. It has also been shown that bile (Neufeld, Truche, Cotoni and Raphael) never dissolves streptococci, whereas in most cases the pneumococcus is dissolved, especially in cases where the sample was virulent for man.

Streptococcus, after twenty-four hours in bouillon, makes a deposit, and the liquid is clear, but the pneumococcus usually grows at all heights of the liquid. Another means of diagnosis is by the inoculation of the mouse. The streptococcus does not usually kill the animal, but when it does, one does not find in the blood the capsulated diplococcus characteristic of the pneumococcus.

We have dealt at length on these cultural conditions because of the possibility of manufacturing an anti-pneumococcus serum and of the necessity of ascertaining for its use the presence of pneumococci. This leads us to consider the division of pneumococci into four separate groups, which has been established by several authors, namely Avery, Chickering, Cole, Dochez, Gillespie in America, Lister in South Africa, and by Nicole and Debains in France. The distinction of these different groups is based on the agglutination by specific sera, but

no distinction exists from a dissolution point of view, so that one serum is bactericidal for all of these groups.

Several anti-pneumococcic sera have been manufactured by Pane, Roemer, Truche, and it has been advised by Imre, amongst others, to inject such serum before operating as a preventive of pneumococcic infection. For over two years in 320 operations on the eye at the Lariboisière Hospital, I have injected 20 c.cm. of Truche's serum a few hours before operating. I have, however, in one case had a mild iritis, three times irido-cyclitis with hypopyon, but a bacteriological examination was not made, the complication disappearing rapidly. In another case where the lacrymal duct was strictured the infection was more severe, and an enucleation was necessary. Pneumococci were found in the eye.

There is little to be said of *staphylococcus*, as the frequency with which it is found everywhere on the human body has caused it to be a little neglected by bacteriologists. Formerly it was considered as the cause of almost all infections, but later its *rôle* was found to be much more restricted. It has also been shown that there is a difficulty in separating it from the *Epidermidis albus*, which is a normal inhabitant of the human skin and mucous membrane. This is why one is still doubtful as to the *rôle* of the staphylococcus in eye infections in cases where only a few colonies of it develop on cultures, and when none is found on the direct examination of the pus.

As to the microbe of the *subtilis group*, which has been found in a few instances, no exact identifications have been made. In a case of Hess and Roemer, a long bacillus was found which did not grow on usual culture media. No anaërobic culture had been made. It was perhaps the *putrifingens* bacillus, which is strictly anaërobic, and which is known as an infectious agent in traumatic ocular infections.

II.

As we now know the agents of the infective post-

operative complications, we shall see the conditions that favour their presence on the margin of the lids or on the conjunctiva.

It will not occur to any oculist to operate on a patient whose lids are affected by ulcerous blepharitis or folliculitis, because it is known that the staphylococcus is often present in these inflammations.

The danger of infectious complications in patients with watering eyes has long been known, and in these cases it is customary to treat the tear-passage, to take out the lacrymal sac, or burn and close the lacrymal punctum before the extraction of the lens is performed.

Bacteriological studies have given us a partial explanation of this danger, showing us the great frequency of pneumococcus in the conjunctiva in watering eyes.

My pupil Fava has demonstrated, for instance, that in twenty patients affected by dacryocystitis the examination of conjunctival secretion showed pneumococcus sixteen times, streptococcus twice, and that after treatment by dacryorhinostomy (Toti's operation) these microbes disappeared. In any case, no infectious complications appeared after cataract extraction in these 20 cases treated by dacryorhinostomy.

It may be a good precaution to make a bacteriological examination of the conjunctival secretion in all cases where the tear-passage has been affected and treated, and to operate only when pneumococcus is not present.

Are we able, by chemical treatment, to destroy the pneumococcus? Several products have been indicated which have this property *in vitro*—for example, bile, optochin, etc. Unfortunately the irritation of the mucous membrane caused by their use is too strong, and we know that such irritation is succeeded by an exudation of serum which may favour the proliferation of microbes.

In comparing two series of operations—in one I used only physiological salt solution for washing; in the other a weak solution of oxycyanide of mercury (1 per 6000)—I have been able to appreciate a better result in the

latter. It is possible that this weak solution has some action upon the vitality or the virulence of the pneumococcus, but it is difficult to establish the demonstration.

I have especially insisted upon the frequency of pneumococci in lacrymal affections, because it is now the most frequent agent of operative infections and the one of which we know the most. It seems to me necessary to repeat that other unknown microbes may surely, just as the pneumococcus, be more frequent on the conjunctiva when the tear-passage is affected.

It is rather curious to see that it has never been reported that a specific agent of conjunctivitis, such as the diplobacillus, has been the cause of infection after operation for cataract. It is nevertheless probable that if one operates for cataract on a patient affected by diplobacillary conjunctivitis, the diplobacillus might be the cause of ocular infection.

With some patients whose mucous membrane is injected, but in the exudation of which no special microbes can be found, the operation can be done without danger, but it is always more prudent first to try to reduce the inflammation by the usual means.

III.

The rapidity with which a well-cut wound closes shows that the infectious agent as a rule can penetrate only during the operation. On the contrary, if the wound is complicated by the interposition of epithelial tissue, by iris tissue, or parts of the lens or capsule, infection may take place after the operation during the first days or even later.

If it is rather easy to disinfect the conjunctiva for a short time, such as during the operation, we know that prolonged disinfection becomes very difficult to effect. Therein lies the great danger of prolapse of the iris when this prolapse is not covered by mucous membrane.

Therefore one of the great improvements realised in the fight against infection is the modification of the

technique, which has for its object the prevention of prolapse of the iris (by iridectomy or suture of the cornea).

The care with which the operator cleanses the wound and puts the tissues back in their place is of great importance for the prevention of secondary infection. It is established that conjunctival wounds are more quickly healed than corneal wounds, and it is more and more customary to cover the sclero-corneal incision with a conjunctival flap.

The following is an example of such a case of secondary infection in connection with a prolapse of the iris :

A woman, æt. 76 years, had a stricture of the tear-passage without suppuration of the sac. The extraction of the lens was performed without incident on February 8th, 1916, with a small regular iridectomy and a conjunctival flap. On February 11th everything was normal ; the chamber was re-established, the wound well closed ; no irritation.

During the night of February 11th the patient began to complain. The day after we found a little lateral pinching of the iris, with purulent infiltration of the wound and hypopyon. In spite of cauterisation by galvanocautery, sub-conjunctival injections, etc., the infection reached the deep membranes, and it became necessary, in order to relieve the pain, to perform enucleation on February 24th. The direct examination of the pus and cultures showed the presence of pneumococcus.

Evidently in this case the penetration of pneumococcus did not happen at the moment of the operation, since the examination, three days after operation, showed everything in order, but it occurred at the moment of the disjunction of the wound and the pinching of the iris by a cause which we were unable to decide.

It has long been demonstrated that badly-healed wounds —that is to say, wounds in which a part of iris, capsule, or lens has been left, thus preventing the proper closing of the anterior chamber—are predisposed to *late* infections. Nevertheless, it seems to me impossible to

attribute all cases of *late* infection to this complication, for we also see this *late* iritis or iridocyclitis develop when the closing of the wound is perfect. As I have already stated, it is a fact which needs further investigation.

Must we attribute great importance to the question of general health as regards infectious complications? Are diabetic or albuminuric patients more liable to these complications? My personal experience has long convinced me of the equality of risks.

Dr. A. Maitland Ramsay (Glasgow):

In the belief that personal experience, even although it be limited, is always of interest, I asked Dr. Alexander Garrow to examine my records of extraction of senile cataract for the past twenty-three years, and to tabulate the cases in which immediate infection of the wound had occurred. This paper, therefore, is based on a study of 2146 consecutive cases, which were not selected. In no circumstance was operation refused if there seemed to be any chance of restoring useful vision. Every precaution was taken, however, to ensure that, as far as possible, the field of operation was free from infecting micro-organisms, and that the general health of the patient was as satisfactory as the individual circumstances permitted. If lacrymal obstruction was found to be present, the operation was postponed until the stenosis had been treated. Extraction of cataract was not performed unless a culture taken from the conjunctival sac proved to be sterile, or at most showed only a few colonies of *Staphylococcus albus*.

Infection of the wound occurred in 68 of the 2146 eyes operated on, *i. e.* in 3·16 per cent.: of the 68 eyes infected 46 were lost and the majority of these were enucleated. Loss of the eye from immediate infection of the wound occurred, therefore, in 2·14 per cent. of the total number of the eyes operated on. Latent infection of the tear-passages was the chief source of infection, and in the great majority of cases the pneumococcus was the

infecting microbe. The operation wound can, however, heal in spite of the presence of micro-organisms. Indeed it is doubtful if cataract extraction is ever performed in circumstances in which the field of operation is aseptic. In many instances, cultures taken from the conjunctival sac before operation were found to be sterile, whereas cultures taken at the time of the first dressing after the operation contained virulent pyogenic organisms. These, however, had apparently in no way interrupted the normal healing of the wound. Such post-operative observations on cultures from the conjunctival sac demonstrated that the conjunctiva can deal with infection, and, as the wound of the cornea usually closes very rapidly, it is not surprising that losses from suppuration after cataract extraction were few in the pre-antiseptic days, when compared with the general results of the operative surgery of that time. A very remarkable case in the present series is that of a man who, on the day following an operation for cataract extraction, was seized with erysipelas of the face, including the eyelids. A culture from the serous exudate in the conjunctival sac showed an almost pure growth of streptococcus. There seemed little doubt that the wound in the eye would become infected, but it remained closed and healed uninterruptedly (Case 576).

There was an old tradition that suppuration after cataract extraction was most liable to occur during very hot or very cold weather, and personally I have always been particularly anxious regarding any patients on whom I had to operate in those seasons of the year when the air was laden with fog. A study of the cases under consideration, however, shows that there was no special liability to suppuration in any particular month of the year, but that cases occurred in sporadic outbreaks of one, two or three on successive operating days. In my own experience, months, and even as long an interval as three years, have passed without any case having become infected, and then, without any apparent reason, an eye would suppurate. Past experience had warned us that

misfortunes of that kind rarely come singly, although it was always very difficult to discover the source of the infection. An unfortunate series of three consecutive cases was suspected to be due to direct infection by a nurse, who at the time was suffering from an acute septic arm following vaccination, and who was on duty owing to the fact that she had not reported her disability. Latent disease of the tear-passages is greatly to be dreaded, and may not be discovered until after the operation for cataract extraction has been performed. Extirpation of the lacrymal sac does not always ensure safety. In a patient in whom both eyes were lost, every precaution was taken before the operation on the second eye; the lacrymal sac had been successfully extirpated and a culture from the conjunctiva was demonstrated to be sterile; nevertheless immediate infection of the wound in the cornea occurred, and bacteriological examination revealed the presence of the pneumococcus (Case 637).

The 2146 eyes can be arranged in three groups according to the method of operating:

(1) Simple extraction, 125.

(2) Extraction after preliminary iridectomy, 752.

(3) Combined extraction, 1269.

In the simple extractions no case of immediate infection occurred. After preliminary iridectomy there were 21 cases of infection, *i. e.* 2·79 per cent., and of these, 14, or 66·7 per cent., of the eyes were lost. In the combined extractions 44 cases became infected, or 3·46 per cent., and of these, 32, or 72·8 per cent., was lost. Escape of vitreous humour occurred at the time of the operation, and the lens had to be removed with the vectis in 10 of the cases which became infected, and of these, 8, *i. e.* 80 per cent., were lost, the rupture of the hyaloid having removed a valuable protective barrier against the spread of infection. Of the 68 eyes which became infected, 13 were known to be diseased—detachment of retina, choroiditis, iridocyclitis, etc.—and of these, 8, or 61·6 per cent., were lost, whereas in 30 the patient was known to be

suffering from impaired general health, *i. e.* albuminuria, arterio-sclerosis, diabetes, glycosuria, myxœdema, bronchitis, etc., and of these, 20, or 66·7 per cent., were lost. In one the patient was operated on within a few weeks after an apparent recovery from influenza (Case 605), and in another the operation was performed four weeks after the patient's discharge from the Smallpox Hospital (Case 261) ; in both of these cases the eyes were lost from immediate suppuration of the wound.

The large percentage of eyes lost after infection—67·7 per cent.—shows that treatment is of little avail in arresting the progress of the suppuration. Destruction of the focus of infection with the actual cautery, or cauterisation of the wound by powerful escharotics, or the introduction of antiseptics into the anterior chamber, seemed to precipitate rather than to retard the course of the inflammation. Personal experience has proved that little more can be done than to keep the eye clean by frequent irrigation with hot saline solution, and to instil argyrol in 20 per cent. solution to assist in the cleansing of the conjunctival sac.

For many years, ever since Darier first drew attention to its value, antidiphtheritic serum has been perscribed in my clinic in all cases of infection. Its use is, as a rule, unaccompanied by any constitutional disturbance, but 2000 units administered subcutaneously every twelve hours until three or four doses have been given greatly relieve the patient's suffering, and the treatment modifies the course of the suppuration in so far that fulminating panophthalmitis very rarely occurs. The rapid change for the better after the use of antidiphtheritic serum is apt to encourage a too hopeful prognosis, but of the 22 infected eyes in which serum was used 59·1 per cent. were lost, as compared with a loss of 67·7 per cent. of the total number of the 68 infected eyes which are being considered in this paper. After the eye is definitely lost, the sooner it is removed the better. It is generally believed that sympathetic inflammation never occurs after suppur-

ative panophthalmitis; but in a man whose left eye was destroyed by suppuration after cataract extraction, sympathetic inflammation occurred in the right eye two months after the operation. Enucleation of the shrivelled stump was performed without delay, but had no effect on the progress of the iridocyclitis in the left eye, which ultimately became blind (Case 20).

Mr. Harrison Butler (Birmingham)

thanked Dr. Morax for his able exposition of the bacteriological side of infection after cataract extraction. He had had the advantage of visiting Dr. Morax's clinic in Paris, and had admired the careful methods which were there adopted to avoid infection from without; he most strongly advised any member of the Congress who could do so to visit the clinic and see for himself.

He felt that there were many who, like himself, felt the need of a *résumé* of the most recent work on the bacteriology of infection—a need which had now been supplied.

Dr. Morax had dealt with exogenous infection, and this was undoubtedly the most important, in that much could be done to avoid this source of trouble; in fact, he felt that it was almost dangerous to suggest that there was another aspect of the case—that eyes could be, and were, lost from an endogenous infection. It was a dangerous doctrine if it led to the slightest relaxation in our aseptic technique.

Still, he could not conceal the feeling that some at least of the serious cases of irido-cyclitis were not due to an exogenous infection, but to organisms or toxins carried to the eye by the circulation. He had made a most careful study of all the cases of this type that had occurred in his practice during the past fifteen years in England and also in the East, and he was forced to the conclusion that some of them were endogenous in origin. He had recently read a paper on the subject, which was contained in the *Transactions of the Ophthalmological*

Society (vol. xl, p. 181). Members could read this paper, so he would only outline the facts which had led him to think that there could be an endogenous infection :

(1) A type of cyclitis, similar to post-operative cyclitis, was not infrequently seen in old persons, chiefly women, who had received blows upon the eye without any perforating wound.

(2) In Palestine, where he had worked for four years in the British Ophthalmic Hospital, they were obliged to operate upon patients whom he would not look at in England. The majority suffered from trachoma, and they had advanced pyorrhœa with spongy scorbutic gums. It was singular that ordinary iritis was seldom seen in the out-patient department, and if a patient had to be treated for iritis it was generally found that he had been contaminated with civilisation, and came from Jaffa or Egypt. Although the patients were often personally dirty, and the operators used only the ordinary aseptic precautions, yet cyclitis after extraction was almost unknown. There they had all the conditions favourable to external infection, yet cyclitis did not occur. Panophthalmitis was seen in about 1 per cent. of the operations—a larger proportion than in England—and this supported the view, which no one would combat, that panophthalmitis and wound suppuration were always caused by external infection.

(3) Post-operative cyclitis was far more likely to affect the second eye operated upon than the first. If one eye was lost from cyclitis it was the rule for the second eye to be affected even more rapidly and severely. This fact afforded a mathematical proof that infection was not likely to be from without, or that if so it was due to an abnormal lack of resisting power. If, for example, they granted that in 100 extractions five eyes were affected with iridocyclitis, the algebraical probability that any two cases would occur in the same patient was so slight that it amounted to an impossibility.

(4) The condition was far commoner in women than in men. Of fifteen cases which followed a normal opera-

tion, eleven were in women; and even when he excluded all possible causes, such as diabetes, the remainder were all women. One of these had since undergone an operation for fibroids. The logical conclusion he came to was, that there was a factor in women which was absent in men which might render them very bad subjects for extraction. He did not see how they could avoid the opinion that this factor was connected with the genital sphere. He cited a case in which a patient of his had her lens extracted. There was no pathological injection, and she left the hospital with a white eye. Yet iridocyclitis set in, and the eye had to be removed. Every effort was made to trace any possible source of infection, but in vain. Six months later a preliminary iridectomy was performed upon the remaining eye. Iridocyclitis set in at once, and the eye is now soft and shrunken. In this case the cultures made from the eye upon agar smeared with blood and incubated for forty-eight hours were sterile. He could not think that there was an exogenous infection in this case.

Mr. Butler said that he took every possible aseptic precaution upon the lines employed by Dr. Morax, and yet these cases occurred from time to time.

He did not think that he was getting as many cases as he used to do, and he believed that increased attention to asepsis, more careful culture work, and examination of the state of the mouth and of the general condition of the patient, were having a good result. He felt, however, that if these cases were due to outside infection greater attention to the details of aseptic technique should have more effect than he had observed. The difference between the results of men who adopted rigorous methods and those who used ordinary aseptic procedures was not great—in fact, almost negligible.

Some facts he had observed after needling soft cataracts in children afforded support to the theory of endogenous infection. He used to regard infection after discission as always due to dirty surgery, and he had never had a case

till suddenly in one year he lost three eyes. In one case a child was found to have a whitlow which had been overlooked. Another developed general furunculosis, and a third died a month after the eye had been removed from meningitis, which was said to be pneumococcal. Here there were three children, all showing signs of general sepsis, and in all three the eye became affected with a destructive iridocyclitis. Another adult nearly lost an eye after discission of cataract, and it was ascertained that he had recently suffered from double pneumonia.

He would like to mention a fact in favour of infection from without. He had recently gone through the notes of fifty consecutive extractions in his three hospitals. At the Coventry Hospital one eye was lost; at the Birmingham Eye Hospital, four; at the Warneford Hospital, seven. This showed the effect of environment. At the Coventry Hospital he had a special eye-ward under an experienced eye sister. During the war the efficiency of the department did not suffer, with the result that but one eye was lost and that a fortnight after the patient had left the hospital—the case already recorded. At Birmingham during the war it was almost impossible to get the wards cleaned and dirty cultures were the rule. As soon as the wards were cleansed one at once got clean cultures and no further eyes were lost. At the Warneford Hospital the patients were distributed among the general surgical wards; conditions were most unsuitable for extractions and seven eyes were lost—two from panophthalmitis and the rest from cyclitis. In all three hospitals the operations were performed under the most stringent aseptic conditions.

Mr. John Hern (Darlington)

said he should like to compliment Dr. Morax on the extreme caution and ability he had shown in describing to them what was a subject of the greatest importance. He was sure Dr. Morax had laid them under a deep debt of obligation. He would like to mention two or three

things. Their discussion that morning was limited to infection, but he would like to mention that when he was doing general surgery many years ago he was rather struck with the idea that the pneumococcus was our common enemy, and his experience in eye cases was quite in accordance with the statement of Dr. Morax that the pneumococcus was one of the greatest enemies the operator had to face. It seemed to him, however—and with all respect to Mr. Harrison Butler—that the best plan would be to set aside the question of internal infection, because, from Mr. Butler's own showing, he had not lost an eye from this source. He would rather go on the supposition that there was no such thing as internal infection, though he had never been able to prove it. Nothing had been mentioned by Dr. Morax or Mr. Butler about cocaine as a probable cause of infection, and in this respect he (Mr. Hern) mentioned that certain specimens of cocaine he had subjected to a bacteriological examination contained numerous germs. That was perhaps a source of infection. On the other hand he had always insisted upon the care of the mouth, and he was perfectly certain that a bad mouth was a possible cause. He had seen cases of irido-cyclitis which had been produced from infection of the teeth. Mr. Butler had mentioned his experience abroad, but he (Mr. Hern) had come to the conclusion that the people there were so filthy that their mouths had become immune to the germ. He did not think they could apply that to the European, who had always been advised to avoid infection from the mouth where it could be done.

Mr. E. H. Stack (Bristol)

remarked that he wished to emphasise two points which he thought had not been very strongly brought forward. The first was the importance of the general health of the patient, apart from any organisms which could be found. He supposed it was the feeling of many, but he would say he was much more anxious about the result of cases where albuminuria, diabetes or chronic heart disease, etc., existed,

than he was about the ordinary healthy person, and it was quite probable, when adding up their cases of infection, they would find a larger percentage in the former section than in the latter. The second point he was interested in and felt very strongly about was the operation. It was all a question of a smooth, quiet and beautiful operation, and if there was the slightest hitch he could not anticipate what might happen. Personally he was much more anxious about those cases he had mentioned than any of the others, his opinion being that there was a much larger percentage of infection after slightly faulty technique than when the operation was an almost perfect one. The operation was everything. If a conjunctival flap was cut badly it was more dangerous than if it was not cut at all, especially if it was not quite covering the whole wound. He always thought there was a little more anxiety in those cases than if one cut out at the edge of the cornea. He preferred the flap, and with regard to the infection after operation, he thought that in a clean wound one less often got it. Very rarely was there infection after a clean iridectomy, and as far as infection after needling was concerned, he was of the opinion that the bruising made by the wagging of a round needle might allow organisms to get in after the operation. Therefore he advocated most earnestly the importance of manual dexterity as the method for preventing infection.

Mr. P. H. Adams (Oxford),

referring to infection from teeth, said he now always insisted upon all mouths being put in a proper state before starting on operations. People, especially old country folk, allowed their mouths to get into an appalling state. Getting rid of the teeth was not a very serious matter as they were usually useless to their owner. The danger of such infection was impressed upon him a short time ago. A certain patient, who was recently operated on for cataract, escaped the mouth inspection by accident. After the operation the eye became inflamed and continued so

for some time. The house-surgeon drew his attention to the patient's bad teeth, and he was sent to the dentist to have them removed, and the result was very alarming. The eye condition became very much worse, presumably from the opening up of the tissues by extraction of the bad teeth, allowing the germs or their toxins to escape into the circulation in greater numbers. It was very important, he contended, that all bad teeth should be removed and the mouth put into a clean and healthy condition at some reasonable time before the operation.

Mr. J. Burdon-Cooper (Bath) :

The material on which I have drawn for my remarks on this discussion comprises some 180 cases operated on in private over the last 10 years, and about 500 odd extractions from the records of the Bath Eye Infirmary, covering a period of 12 years from 1908 to 1920 *seriatim*. In order to save time and to be as concise as possible, I cannot do better than adhere to the admirable scheme adopted by Dr. Morax. In the private cases I find that in no instance have I had an immediate infection or suppuration of the extraction wound. In hospital practice there have been four, which works out at a little lower than 1 per cent. Immediate infection, that is, that coming on within eighteen hours of the section, I attribute largely to faulty technique, using the term in its broadest sense, comprising default in the surgeon, his assistants, instruments, methods, etc., together with the lack of reasonable attention to the conjunctival sac, which, through being culpably unclean, has admitted of direct infection of the wound. It is comparatively easy to determine in such cases the direct factor by making a culture from the wound. If this course in the main agrees with a previous bacteriological finding in the conjunctival sac, the evidence is presumptive that the conjunctiva is the source of the infection; if not, I should consider it as due to a fault of technique, or to a factor not under our control. As we have had privately no experience of immediate infection

within the last ten years, I was interested to hear my nurse's own opinion for the same. I give it in her own words. "Our success in operations for cataract, apart from the operative side, is mainly due to the little handling of the eye before and after operation. The patient is not worried by a lot of preparation prior to operation nor even at the time. It is done in their own bedroom with as little fuss as possible, so that they are really very little agitated. Aperients are given three days and a mild vegetable laxative on the evening before the operation, Drops, dressings, lotions are prepared the previous day. and are re-sterilised on the morning of the operation. Distilled water is used throughout, instruments are all boiled (including the knife), and in private cases we have used lavage of the anterior chamber for at least ten years, the same nozzle and tubing still doing duty."

A brief note on two cases may not be without interest. E. D—, complete cataract right ; L.V. $\frac{6}{36}$. Extraction, R., June 25th, 1919 ; button-hole iridectomy ; 18 hours after, wound septic ; smear showed a mixed infection and a culture streptococci. Nurse G—, under the care of my colleague, had been operated on three days previously in the same ward, and the wound was definitely septic on the fourth day. E. D— was operated upon by me in the same ward on the morning of the fourth day after Sister G— was done, without knowing the case was septic. About 20 hours after there was a virulent infection of the eye in my case, which was lost through panophthalmitis. The difficulty in such cases is not so much in knowing the direct factor, but how it got there. In this case it may have been faulty technique, or as the beds were immediately opposite each other, the organisms may have been air-borne. This bears out Mr. H. Butler's point on environment. Another case, T. S—, double cataract, aged 70 ; extraction March 5th, 1921 ; button-hole iridectomy, septic second day ; orbital cellulitis ; temperature, 101° ; five days' culture showed cocci of streptococcal group, probably pneumococci. Another case was pneu-

mococcal, and was probably of lacrymal origin, which brings me to speak of the immediate factor. Here I think we must realise that almost every known organism has been found at some time or other in the conjunctival sac, and it is impossible to render it sterile. My own experience as far as an immediate factor is concerned is that the less the conjunctiva is disturbed or irritated the better. I have a wholesome respect for it, and put it into practice by avoiding test dressings, strong mercurial or other irritative solutions, which only cause necrosis of the cells and interfere with their vitality. Syringing the lacrymal sac and duct is best done some time before operation, say at the time of making a culture.

The importance of good drainage and sound lacrymal passages is now well recognised, and no syringing with strong antiseptics can be accomplished without decided hyperæmia, swelling, and consequent slacking of the drainage, thus favouring organism distribution. Here I should like to put in a plea for preliminary iridectomy at the expense of probably being labelled "old-fashioned." It gives a good indication of the patient's recuperative power and the behaviour of his conjunctiva, and I have actually had cases which have given me greater trouble and reaction with it than even after the extraction. The information gained is of value.

To come now to late infection. In my private cases I find seven eyes were lost: Plastic iridocyclitis, expulsive haemorrhage on the eighth day through straining at stool (a rare case); serous cyclitis with "K.P.," two cases, induced probably by soft cortical matter remaining behind through faulty technique plus the addition of organisms. Another of diffuse opacity of the cornea and disorganisation of the eye through washing out the anterior chamber with 1 : 10,000 solution of perchloride supplied by mistake for normal saline.

I have gone through a comparatively long list of late infections of the eye which have occurred in hospital practice, many of which have had to be eventually enu-

cleated for fear of sympathetic disease. Mild post-operative iritis coming on about the third day, and lasting varying lengths of time up to the patient leaving the home, which only slightly interferes with the subsequent good visual acuity, is, I feel sure, not infective originally, though it may become so; this would be indicated by progress of the inflammation, by its becoming plastic with narrowing of the pupil, development of synechiæ and perhaps one or two spots of K.P.

I should like to know how far we are right in labelling these cases infective, and, if not, what is the indication of infection? That we may have to go very far afield to find a cause is shown in the following private case—hardly a straightforward cataract, it was a case of plastic iridocyclitis in an old lady of 72. In it I traced an ætiological relationship to a streptococcal apical abscess of the same side. The case had been operated on previously for right cataract; the eye had to be removed for fear of sympathetic. When the patient came to me the other eye was quiet, but there were signs of a mild cyclitis and one or two spots of K.P., and cataract nearly complete. After the greatest care and general treatment, inspection of the teeth a second time (they had been gone over before), I was persuaded to attempt extraction. The result was deplorable. A severe plastic iridocyclitis followed the operation almost immediately and defied treatment. At the end of the month I had the teeth examined and a suspicious molar was removed, and from it a streptococcus was isolated. After the use of a vaccine, extraction and removal of the teeth the eye quietened down. Here I think the streptococcus existed in a latent condition in the eye, and in this regard I should like to ask a question of Dr. Morax or others. Is a "K.P." spot always evidence of an organism in the eye itself? The organism in this case, I take it, took advantage of the depressed resistance occasioned by the section, the adjuvant factor being the deficient vitality of the patient consequent on toxin absorption.

The consideration of these late infections brings me to the next heading, namely, the adjuvant factor which favours ocular infection. This factor I should unhesitatingly say is the general condition and vitality of the patient, used in its broadest sense. This field of investigation is admittedly a wide one and in measure accounts for a scant knowledge of late post-operative infections, and it is here I think there is the greatest room for advance. My own ignorance of them was colossal, and I can only state my own views as they shape themselves in my mind.

The chief focal infections encountered in the practice of ophthalmology to-day are the teeth, tonsils and intestines. These I consider are not fads, but are realities to be looked for and eradicated if our operations are to be successful. Deep-seated and hidden foci of oral infection are most virulent, and one would emphasise the importance of a routine tonsillar examination, as the tonsils are not only receptors, but transmitters of many infectious processes. Errors of diet, pyorrhœa, undue use of sugar are the starting-points of hyperacidity and toxæmia, for every inflammation from the crown of the head to the sole of the foot makes greater headway in an acid body. Urinary acidity is a point one would pay considerable attention to in cataract patients. I should have great hesitation in operating upon a case with a urinary acidity of more than 40 units of decimal normal soda solution without previous treatment by alkalies. My impression is that the liver is the great defaulter in producing relative acidity of the tissues, thus favouring inflammation and infection. The products of the bile, especially the acids, are extremely irritative to both muscle and nerve.

I have recently had two cases which forcibly impressed upon me this fact: in one the patient indulged in a heavy supper on the night before admission, with the result that after the extraction he was ill. There was copious bilious vomiting, and the eye on the next day looked as if it was on the verge of panophthalmitis. The case cleared up on

aspirin and soda. The hospital case was exactly similar; for two or three days there was a copious dark copper-coloured vomiting and the anterior chamber was turbid, but cleared when the vomiting stopped. The wound healed well, and the patient was discharged in record time. The appearance of these cases is decidedly alarming. I think it is because of their reducing this acidity that aspirin, bicarbonate of potash and soda do so well and are so useful in post-operative inflammatory conditions.

I have little time left to say anything about intestinal toxæmia, but this plays an important part in ocular infection. Prof. Lewis even goes so far as to say, speaking of the ætiology of lenticular changes, that every patient presenting such a condition is suffering from intestinal toxæmia. Ziegler has recently emphasised the importance of sub-oxidation. From our experience in ocular infection in general no treatment seems at all effectual until the teeth, urethra or uterus are treated, and I should warn against operations being undertaken near or during the menstrual period. In a recent hospital case the eye became septic on the third day. The patient had started menstruating the day after she was operated on and there was no sign of wound sepsis. Panophthalmitis followed and the eye had to be enucleated.

In my experience of focal infections of the eye the infection is as a rule chronic and of low virulence, and it is important to bear in mind that more than one focus may have an ætiological bearing on the condition at the same time. The commonest organisms met with in operations are the streptococcus and pneumococcus, to which may be added in several cases the gonococcus.

Mr. N. C. Ridley (Leicester)

said he was of opinion that acute infection might not find itself in the first few days. He remembered two cases where the eye had acute suppuration, though it looked all right for the first nine days. Fortunately in these two cases recovery took place, although the anterior chambers

were full of yellow pus. Considering that the eye was a closed cavity and that he was not justified in opening it for taking a culture, he injected anti-*Staphylococcus aureus* vaccine and also prescribed mercury, and the infection disappeared. Concerning the part environment played, he said there was not the slightest doubt that it was very important. Infection took place after the operation in many cases, because in the first place private cases always did better than hospital cases. At Leicester the aural surgeon was allowed to have a number of beds in his (Mr. Ridley's) wards, and as these were mostly cases of mastoid disease he found repeatedly that certain eye cases were going wrong with infection after the operations. Subsequently he had the aural surgeon excommunicated and the eye operations went better afterwards. For many years he had used double cyanide ointment immediately after operation and the results were thereby improved. It was absolutely impossible, he contended, to sterilise the conjunctival sac, and he maintained that it never could be sterilised. Then, again, in eyes in which the cornea was very flabby and collapsing, on restoration to its original position there must be, he thought, a certain amount of suction of whatever was handy, and in such cases he always irrigated with saline solution. Following Devereux Marshall, he made the puncture for discission through the conjunctiva at the corneal margin, and in this respect, too, he thought there was a greater chance of the wound healing without danger of infection.

Major A. E. T. Lister, I.M.S.:

During the last twenty years I have operated on a large number of cataracts and have tried most of the better-known methods of operation. I have also had the opportunity of seeing a very large number of operations done by others, and of seeing the immediate after-results.

This Congress is valuable, in that we have an opportunity

of hearing others' experience. I will give you mine on a few points for what it is worth.

(1) As to the value of the use of antiseptics in the conjunctival sac before operation in combating infection after cataract operations.

We all agree as to the value of a positive finding in a bacteriological examination, but what about a negative one?

While working in one of the best-run clinics on the Continent of Europe, where there is a splendid bacteriological department in charge of a well-known bacteriologist, I was told of a case in which one eye was lost by a pneumococcic infection. The other eye was treated most carefully, and after being found free from bacteria several times it was operated on, several months after the other. It also was lost from pneumococcal infection.

In my clinic, with a large number of operations every week, it was quite impossible during the war to have a bacteriological examination made in every case, desirable though it may be. In other hospitals where I have worked it has also been impossible.

I was led, therefore, to adopt preventive measures, and in view of cases such as I have mentioned, I should be very loth to abandon them, even if the eye were pronounced free from infection.

The measures I adopt, are to have the conjunctival sac washed out with a lotion containing 1 in 4000 perchloride of mercury, about a quarter of an hour before the operation, and the use of a douche of 1 in 3000 of perchloride before operation. I have the lotion in a large receiver, attached to a pulley so that it can be raised to about 8 to 10 feet above the patient's head.

I believe the forcible mechanical cleansing which results from the pressure is of value in thoroughly cleansing the conjunctival sac. Before the douche is used I thoroughly clean out the conjunctival sac with a swab, everting the upper lid, as the use of the perchloride causes a little mucoid secretion.

Perchloride of mercury is undoubtedly very irritating

to some eyes. I have had the experience of having my own eye irrigated with 1 in 2000 perchloride of mercury and it caused great irritation. I have not as a matter of fact had any complaints from my patients, European or Indian, possibly because after its use they keep the eye closed, and also possibly because I give potassium bromide as a routine measure before operations. I do not think that the perchloride kills the micro-organisms, but that it hinders their growth in the conjunctival sac, if present.

It is interesting to note in this direction that recently Dr. David, the Chief Medical Officer in Galilee in Palestine, as the result of much experience in schools and with labourers, found that the use of a 1 per cent. solution of zinc sulphate to which had been added 5 per cent. of 1 in 1000 adrenalin was most effective in preventing the seasonal attacks of catarrhal conjunctivitis so common in that region at certain seasons. His results were confirmed by the observations of Friedenwald, of Baltimore, who was working there too. David, in *La Presse Médicale* for November 17th, 1920, quotes Raulin's experiments. He found that a culture of *Aspergillus niger* would not grow in a silver vase, though no antiseptic action was found in the solution and no silver was chemically detectable.

There seems ground, then, for thinking that the previous use of perchloride does impede the growth of micro-organisms.

It has been tried with great success in India. Bamber in 1894 was the first to describe its use, so far as I know. Smith, Herbert and many others have used it with great success, Smith using it as strong as 1 in 2000.

(2) I fully agree as to the value of a perfect technique. The less trauma, the quicker will be the restoration of normal conditions, so important in preventing infection.

Personally I never, if I can possibly avoid it, put an instrument twice into the interior of an eye without its being re-sterilised. I keep a number of spare instruments in a covered tray on the instrument table in case of necessity.

(3) I think the choice of an operation is important, but will not deal with this beyond saying that I think one of the great arguments for intra-capsular extraction by some method is that it leaves no dead lens matter in the eye to serve as a culture medium, and no capsule to get between the lips of the wound. I am aware this operation has its own peculiar difficulties, on which I will not touch.

(4) Lastly, in eyes that are dressed the next day or two days after operation special care should be taken to prevent the patient putting a strain on the wound and thus opening the road to infective organisms. A wound in the eye, like other surgical wounds, requires time to heal.

If a patient's eye is suddenly exposed to a bright light he is apt to close his eye forcibly and put a strain on the wound.

I always control the orbicularis muscle with my thumb when inspecting an eye after operation, and if the light is bright, shield the eye from it with a screen. The patient should be made to look down as little as possible, as looking down puts a special strain on the wound if in the usual position above.

One perhaps realises this more when one has to deal with the larger sclera-corneal wounds of intracapsular extractions. I have seen a case in which the wound, which looked quite in good position and everything normal, developed post-operative escape of vitreous after being told to look down on the fourth day so that a medical officer might inspect the wound. Such cases should not be made to look down for at least ten days.

The smaller wounds of the older operations would not be so liable to reopen, but it is conceivable that the strain may disturb or break down the exudation sealing the wound, and allow of the entrance of micro-organisms.

In any case, it is a point, I think, well worth bearing in mind, and this must be my excuse for bringing it before the Congress.

Mr. Johnson Taylor (Norwich)

said it had been mentioned that iridocyclitis was more frequent in women than in men. It was quite true that women were much more apt to be constipated; they did not smoke so much as men, and they did not take necessary exercise like the other sex. It was, he thought, a question of absorption from the bowels. Mr. Butler had referred to cases in Palestine where there was a large number of very horrible eyes; but was it not a fact that one germ lived upon the other, on the principle that "Great fleas have smaller fleas on their backs to bite them, etc."? How was it that in acute and chronic glaucoma, treated by iridectomy as they used to be, the wound never suppurated? It was a pretty big wound, but he had never known a case where the wound suppurated. In needling for cataract he always passed the needle through the conjunctiva. In the one case the germs were wiped off the needle, and in the second it was not the case. It had also been said that the cornea tended to suck in germs. His idea was that the process was against that—not by sucking in but by pushing out. He had for many years given up washing out the conjunctival sac before operations. The operation of washing out might, in part, sterilise the conjunctival sac, but could not remove all the germs, and his (Mr. Taylor's) results had been no worse since he gave it up. Simple extractions he contended were the best. Mutilation of the iris tended to increase the tendency to various post-operative complications. He was glad to see that Mr. Treacher Collins had taken a strong exception to the combined operation and now did the simple extraction.

2. *The effects observed in certain diseases of the eye after the intravenous injection of salvarsan or its substitutes.*

By John Hern (Darlington).

The preparation of the patient is not important, but as far as possible an empty stomach is desirable, since sickness and vomiting are sometimes experienced.

In hospital cases 90 per cent. can be treated as out-patients quite safely if they are allowed to sit quietly for half to one hour after the injection; but in the case of private patients the rule should be to admit to a nursing home for at least twenty-four hours in bed; then, if no effects are noticed, they may be discharged at once. The effects of the injection usually occur within the first few hours; these are flushing of the face with giddiness, and if walking is persisted in a falling forward if not supported, eczema, or jaundice, or coma. I have had no experience in my cases as they have not occurred; but I may mention a case sent into hospital under my care with extreme jaundice and coma, which died in twenty-four hours. A piece of liver was submitted to the pathologist, who reported *Spirochæta pallida* present in large numbers, and on inquiry the doctor who sent him in stated that he had had no anti-syphilitic treatment whatever.

The operation is quite simple. An elastic tourniquet is placed around the upper arm 2 or 3 in. above the elbow just tight enough to stop the venous return, the patient is asked to open and close the hand a few times to bring the median basilic or cephalic vein into prominence, the skin is carefully rubbed by a wad of cotton-wool saturated with spirit, and the needle passed through the skin into the lumen of the vein, care being taken to pass the needle in the exact direction of the vein so as to keep in its lumen as there is a danger of piercing it and entering the tissues beyond; to ensure the needle being actually in the vein the plunger should be withdrawn a little, when blood should enter freely the barrel of the syringe.

The army outfit may be used, but a record syringe sterilised by boiling and a 2-in. moderate-sized needle occupies much less time and gives equally good results.

As to drugs used, I first used kharsivan (Burroughs, Wellcome & Co.), a reliable preparation, but one which will not dissolve in cold water, and which must be neutralised by KOH or NaOH, and the 0·50 dose is so often followed by flushing of the face and giddiness. I have chiefly used novarsenobillon, 0·50 for females and 0·75 for males, and I have found it most satisfactory; it is effectual in bringing about a negative Wassermann, and is almost free from after-effects; it is soluble in cold distilled (and it should be freshly distilled) water, and is alkaline.

The eye cases most urgently demanding this treatment are those active and most aggressively acute cases attacking the cornea, in which in twenty-four hours or less the "iritic ring" becomes extremely congested, the cornea opaque and threatening to break down in the centre, accompanied by much pain and lacrimation.

If the salvarsan or its substitute be injected the process is stopped as if by magic, but if this is not done the eye is rapidly lost by the cornea breaking down and panophthalmitis supervening. When the case presents itself in this stage there is no time to get a Wassermann test, and I strongly advise an immediate injection, for having injected a great many cases of acute iritis, acute iridocyclitis, choroiditis and choroido-retinitis, no aggravation of the trouble has resulted, and there has often been an almost immediate relief.

The above-described condition of rapid disintegration of the cornea reminds me of the cases one has seen of syphilis attacking the pharynx, where, if large doses of iodide are not given at once, large sloughs separate and much damage is done.

On applying the Wassermann test to all the cases attending the ophthalmic out-patient department of the hospital where syphilis has not been suspected, I have been amazed at the large percentage of positive results

obtained (30 per cent.); some cases were so obviously due to syphilis that no test was applied, but I cannot too strongly advise a more general use of this test in out-patient clinics as a guide to treatment, and certainly the intravenous "914" is the most effectual and rapid, and should be accompanied by the "gr. j metallic mercury" injected intramuscularly.

As to the frequency of injections, it is generally acknowledged that except in very acute cases, in which an interval of three days only should be allowed between the first three doses, a spread-out treatment is the safer. Each case should be treated on its merits. As to the reaction of the drug, as a rule there should be a week's interval between the first two doses, and then a fortnight should supervene; as to how many doses are required for a complete treatment, about eight to ten doses in a chronic case and seven to eight in a recent case will usually yield a negative result, but the Wassermann test should be reapplied every four months for two years in a recent case and for three or four years in a long-standing one. There can be no doubt of the value of the Wassermann test if done by a reliable bacteriologist, but there can be equally little doubt that it is a good servant but a bad master. The usual clinical manifestations of syphilis are a more reliable guide to diagnosis than the Wassermann reaction.

In conclusion, I am convinced that much benefit has followed this treatment in cases with a negative Wassermann and in which no clinical symptoms indicate syphilis, and I find in general that our surgeons are impressed also with the action of intravenous arsenic in some of their surgical and skin cases which certainly are not demonstrably syphilitic; are they latent syphilis, or does the arsenic act in cases not syphilitic? Here is a subject worthy of investigation, and I for one should like to hear the opinion of the members of this Congress who have used such treatment in their eye cases.

I have omitted to mention the good effect of "914"

on the kerato-iritis of inherited syphilis if the treatment is carefully persisted in, since the curative effects are often delayed in these cases.

3. *Macular disease, with special reference to acute primary macular disease.*

By Rayner D. Batten (London).

Mr. Rayner Batten offered tentatively the following classification of macular diseases, and showed drawings illustrative of various forms of macular disease.

Classification of Macular Diseases.

A. Familial.
1. *Infantile.*—Amaurotic family idiocy. (Peculiar to the Hebrew race.)
2. *Juvenile.*
   (a) *Ocular.*— i. *Progressive.*—Leading to optic atrophy.
   ii. *Non-progressive.*—Ending in partial recovery.
   (b) *Maculo-cerebral.*—Onset in childhood. Associated with cerebral degeneration.
3. *Adult.*—Progressive macular changes with but little defect of sight.

B. Non-Familial.
1. *Congenital.*
   (a) *Developmental.*—True coloboma.
   (b) *Non-developmental.*—False coloboma, perhaps due to intra-uterine inflammatory process.
2. *Juvenile.*
   (a) *Primary Macular Disease.*—Followed by secondary optic atrophy.
   (b) *Secondary Macular Disease.*—Following optic neuritis. Coincident with secondary optic atrophy.
3. *Adult.*
   (a) *Progressive.*—Extending to choroido-retinitis beyond macular area.
   (b) *Non-progressive.*—Macular area only involved. Permanent macular changes, but partial, or complete recovery of sight.
4. *Senile.*
   (*a*) Senile degeneration.
   (*b*) Tay's choroiditis.
   (*c*) Senile macular choroiditis.
   (*d*) Retinitis circinata.

He said that he wished to endeavour to establish acute primary macular disease as an entity distinct from the familial group.

He believed it to be a fairly common disease, but as it did not necessarily affect vision sufficiently to make the patient seek advice, it frequently passed unnoticed. It was, however, responsible for the not infrequent slight forms of choroido-retinitis in the macular region, with good, or but slightly affected vision.

The disease appeared to be sporadic and not associated with any family tendency, though the family history should always be investigated. It was a disease chiefly of young, adult, or middle life, more or less acute in its onset, running a course extending over some months, but tending ultimately to become quiescent. It affected both eyes, but although macular changes were found in both, one only might show defect of vision. Where only one eye was affected he was inclined to attribute it to other causes.

The vision might be affected before any fundus change was visible, giving rise to a partial central scotoma, resembling in this symptom retro-bulbar neuritis, but without its confirmatory symptoms.

On the other hand, there might be marked ophthalmoscopic changes without any defect of vision, so that it was possible to have one eye with good vision and macular changes, and the other eye with defective vision and no visible changes, though changes might appear later.

The disease tended to run a course and ultimately to become quiescent.

It might leave only slight macular changes and very little defect of vision, or it might extend beyond the macular area and give rise to more serious defect of vision. The defect of vision and the degree of fundus change did not appear to bear any definite relation to each other.

The causes of this disease were uncertain, though the balance of evidence obtained was in favour of its being

toxic, probably septic in origin. Mr. Batten quoted cases in pyorrhœa, suppuration of the nasal sinuses, gonorrhœa, influenza and pregnancy. The onset might be accompanied by scleritis or deep conjunctivitis, with some ocular pain, which would be evidence in favour of a general septic cause.

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4. *The trench operation for glaucoma.*

By N. C. Ridley.

Taking it as a postulate that hypertension is the chief cause of all the bad symptoms of chronic glaucoma, although this is by no means universally conceded, the object of all the operations at present devised is to relieve that tension, at the same time avoiding:

(1) Hypotony.
(2) Late infection.
(3) Interference with vision from distortion of the normal curvature of the eyeball.

With this object in view many operations have been planned to produce a communication between the anterior chamber and the subconjunctival tissue, so that whenever the intra-ocular tension is raised above the normal, a certain amount of aqueous may escape into the lymph-spaces outside the globe. To avoid the first and third evils the channel of communication must not be too large, and too much tissue must not be removed, and to steer clear of the second we must have a sufficient covering to prevent a possible accidental communication with the exterior, and so afford a means of entrance to the interior of any organisms from the conjunctival sac.

I do not think it has ever been definitely and unmistakably proved that sepsis-producing organisms are able to pass through the unbroken healthy conjunctiva, however thin, and I myself think that in every case where sepsis has occurred, some injury to the delicate membrane has taken place by pressure from within or without, though

perhaps not necessarily proceeding so far as absolute perforation, or the vitality has been lowered by its having become sodden and juicy. However, our object must be to provide as stout a covering as we possibly can. The channel of communication may be made by a simple corneo-scleral section under the conjunctiva, as in the original sclerotomy, or in Herbert's small-flap operation, or by the removal of a portion of cornea and sclera, as is done in Lagrange's operation, or by trephining or by means of Holth's punch.

To produce, however, the stoutest safeguard against late infection, we must choose an operation which produces an infinite number of minute channels running a tortuous course rather than one large channel running directly into the anterior chamber, so that should any organisms pass through the damaged or ruptured conjunctiva, they may have a longer distance to travel in close contact with hostile living cells before they reach the less resisting iris or ciliary body, where they can settle and multiply so readily. The object of this operation is to produce this result—that is, a wide, so-called filtrating scar.

I make no claim to the merit of having invented this operation. It originated in the fertile mind of Col. Herbert.

It was in 1914 that Col. Herbert was discussing with me the various operations for the relief of chronic glaucoma, and said that the ideal operation would be one that, with a small opening into the anterior chamber, produced a spongy filtrating scar extending over a considerable area. For this purpose he proposed making a long groove or trench, not clean cut, but with ragged sides, through the cornea between the limbus and the corneo-scleral junction, under a large conjunctival flap. He designed an ingenious but quaint-looking instrument to accomplish this, a saw with two blades, set parallel with one another in a handle. The alternate teeth only of each blade were "set," and the set teeth were turned inwards. As the fixing screws projected and had to be

directed forwards, it was necessary to have different handles and blades for right and left eyes.

Very shortly after he had begun his experiments the war broke out and Col. Herbert took up military duty, and wrote asking me to go on with this work of his, which I was very glad to do, and so began on a number of sheep's eyes. These, as you all know, are very unsatisfactory things to operate on. The aqueous has generally disappeared and there is practically no anterior chamber, the space between the conjunctivo-corneal junction and sclero-corneal junction is very narrow and the eye is very flabby, even if the butcher has not punctured the globe in the process of enucleation; it is also very difficult to fix properly. Hence my results were, to describe them mildly, very poor. I therefore next operated on a series of hopelessly blind human eyes, and found the operation very difficult to perform. It was almost impossible to keep the globe steady, and the teeth of the saw at times caught the conjunctival flap and tore holes in it. It took a lot of time, too, to fix the saw blades properly, and also to take them apart and clean and sterilise them afterwards. It became necessary to look round, therefore, for some other instrument to produce the desired result—that is, a rugged groove, not a clean-cut one.

A simple scalpel used sideways, as in dissection, was not bad, but one with the point turned was far better, and this is what I invariably use now. Mr. Thomson Henderson suggested a dentist's burr, and I tried every variety, but found that they do not cut into a fibrous and elastic tissue, but wind any loose fibres round themselves and clog the cutting edges, apart from which they are apt to take charge and suddenly tear holes where not desired.

The procedure to be followed in the operation is as follows: After anæsthetising by means of an intra-orbital injection of adrenalin and novocaine, make with a pair of scissors a slightly curved incision about 15 mm. long in the conjunctiva about 12 mm. from the corneo-scleral junction, and seizing the lower edge with a very blunt

pair of dissecting forceps, dissect it and the subconjunctival tissue down to the limbus, clearing the latter till nearly a fourth of the circumference is exposed. The trench is then scratched in the cornea parallel with the plane of the iris until the anterior chamber is opened at its centre, the depth being gradually less at its extremities. When the aqueous escapes the opening is made about 3 mm. long, to admit a pair of iris forceps in case the iris should not prolapse. A small basal iridectomy is then performed, a repositor is gently introduced to see that the iris is free of the wound, and one suture is used to unite the centre of the conjunctival incision. Double cyanide and atropine ointment is introduced, and both eyes are closed by pads and the patient put back to bed, where he is kept very quiet on his back for forty-eight hours. If there be much reaction, cold pads are used later instead of the ordinary antiseptic dressing. Atropine is discontinued as a rule after three or four days.

If a blunt pair of dissecting forceps be used for holding the conjunctiva it is very rarely torn, but should that occur it may be sutured and no harm result.

The operation, which is a sclerectomy and not a sclerotomy, for quite an appreciable amount of tissue is removed, produces a ragged edged groove or trench of a fan shape, which cannot heal by first intention like a clean cut would do, and being constantly filled with exuding aqueous, produces a spongy scar, providing a wide filtrating area opening into the subconjunctival space. It is almost unknown for a localised bleb with sodden unhealthy conjunctiva to result, such as is so often the case when the aqueous escapes at one spot, as in the trephine operation, but there is usually a diffuse œdematous area communicating freely with the general subconjunctival lymph-spaces, whose thick covering of conjunctiva and subconjunctival tissue forms more of a safeguard against sepsis.

The chief drawback to the operation is that it takes a much longer time to perform than either Lagrange's operation, Herbert's small flap or trephining, but it can

No.	Name	Age	Date	Original Condition.	Operation and date.	Result.	Remarks.
1	Mrs K	59	Feb. 16, 1921	Pain in head. Haloes. T. full. L. typical cup. Diminished nasal field.	R.E. $\frac{6}{9}$; L.E. $\frac{6}{12}$.	L., trench, Feb. 25	April 5: No pain, no haloes. T.n. Good oedematous area. L.V. $\frac{6}{9}$. L.: + 5 D. cyl. ax. horiz. increase in astigmatism	Satisfactory.
2	Rev. M. A. T.	72	Feb. 10, 1921	Failure of L.E. Cupping of both discs. L. worse. T. full. Striæ in lenses.	R.E. $=\frac{6}{9}$. L.E. $<\frac{6}{60}$	L., trench, March 9	May 14: L., all quiet. T.n. Good oedematous area. Field increased. L.V. $\frac{6}{12}$, partly. -1 D. cyl. ax. 60 degrees A.L., increase in astigmatism	Satisfactory.
3 & 4	Mr. W. P.	62	April, 1921	Vision of both failing. Haloes. Glaucoma cups.	R. $\frac{6}{12}$; L. $\frac{6}{9}$.	R., trench, April 8; L., trench, April 15.	June 4: Both quiet. T.n. Good oedematous area. R.V. $\frac{6}{9}$. L.V. $=\frac{6}{6}$. No increase of astigmatism.	Both very satisfactory.
5	Mr. T. K.	66	April 5, 1921	Severe headache. T. + . Cupping of discs. L. worse.	R. $\frac{6}{9}$; L. P.L.	R., Trench, April 7	May 11: R. quiet. T.n. Good oedematous area with small bleb. R.V. $\frac{6}{9}$: + 5 D. cyl., increase in astigmatism.	Satisfactory.
6	Mr. T. W.	57	March 1, 1921	Both discs cupped. T. + . Nasal field contracted.	R. $\frac{6}{9}$; L., no central vision.	L., trench, March 4.	Mar. 22: Quiet. Good uniform oedematous area. L.V. improved, but $<\frac{6}{60}$.	Fair result, considering the condition. Other eye requires operation.
7 & 8	Mr. H. A.	72	April 12, 1921	Both discs cupped and pale. L.V. failing very rapidly.	R. $\frac{6}{9}$; L. $\frac{6}{12}$.	L., trench, April 22; R., trench, May 27.	L., healed with good filtrating scar, but V. diminished until there was no P.L. R., June 18: T.n. Good uniform oedematous area. R.V. $\frac{6}{6}$.	It was difficult to account for this failure of vision as the T. was n. The lens became opaque. No evidence seen of deep haemorrhage. L., result bad; R., satisfactory.
9 & 9A	Mrs A. W.	71	Jan. 21, 1921	Subacute glaucoma of both. Rainbows. R.T. full. L.T. + .	R., fingers at 1 ft.; L., shadows.	R., trench, Jan. 22; L., trephine, Jan. 22; L., trephine, March 11.	Mar. 1: R.V. $\frac{6}{12}$; T.n. L.V. P.L.; T. + . July 2: Both quiet. T.n. R., good oedematous area; L., small bleb over second opening. R.V. $\frac{6}{9}$ nearly; L.V. $\frac{6}{12}$. fi	In this case the two operations were done for contrast. Both results were very satisfactory.
10 & 11	Mrs J. M.	64	May 4, 1921	Both V. failing. T. full. Discs cupped.	R. $\frac{6}{12}$. L. $\frac{6}{9}$.	R., trench, May 10; L., trench, June 24.	R., T.n. Good oedematous area. V. $\frac{6}{9}$: + 5 D. cyl., increase in astigmatism. L., July 1: Quiet. Progressing satisfactorily.	Satisfactory.
12	Mrs W. T.	71	June 4, 1921	Chronic glaucoma of both.	R. $\frac{6}{12}$. L., fingers at 6 in.	L., Trench, June 22.	July 2: L.E. quiet. T.n. Fair oedematous area. L.V. improved, but $<\frac{6}{60}$.	Fair, considering the condition. Other eye to be operated on.

be taken that twenty minutes expresses an average time for it. Fixation of the globe, too, is sometimes difficult, but much depends on the steadiness of the patient, and one does not usually have much trouble.

The complications are much the same as those of all these operations. Button-holes can be sewn up. As I have said, there is less danger of sepsis. Iritis may occur, but is mitigated by the use of atropine. There is practically no pain if the intra-orbital injection be used.

Theoretically one would expect more astigmatism from this operation than from any of the other operations for chronic glaucoma, except perhaps that of Lagrange, but I have not found much in practice.

My results from this operation have been better so far as the permanent relief of high intra-ocular tension is concerned than from any other operation. I have never seen hypotony result from the trench operation, and it is manifestly less likely to occur with a spongy filtrating scar than with a free opening into the globe. So far I have never found it necessary to repeat it on the same eye, but of course it might be done if the condition were not relieved.

On page 417 is a brief abstract of my cases since the beginning of the year when I re-commenced doing the operation. They are not selected; all are included.

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5. *A plea for early diagnosis and operation in chronic glaucoma, with some remarks upon the treatment of acute glaucoma.*

By T. Harrison Butler (Birmingham).

I will first deal with acute glaucoma. You will perhaps be surprised that I am reversing the usual order, and plead for early operation in chronic glaucoma, and for late operation, and perhaps even no operation, in acute glaucoma. For years it has been my practice, and I

believe that it is even now a general practice, to operate upon acute glaucoma as soon as possible. One was taught, and read in the text-books, that there is not an hour to be lost. At the last Oxford Congress I had some most valuable conversations about this subject with Dr. Roper of Exeter and with other members, and I decided to try the effect of the conservative treatment advised by them. During the past year I have had about six cases of acute glaucoma. In all of them with one exception the conservative treatment was successful, and the exception did not yield to any form of treatment. I excised his eye and found a lens dislocated into the vitreous. I now put my patient to bed, instil 1 per cent. eserine solution every two hours, administer morphine injections, give a drastic purge, and apply the hot box. In a few days the eye may be quiet, free from pain, with a lowered tension, and in a week it may be apparently normal. Now is the time to discuss the question of operation, and I think that in some cases—when we can keep the patient under close observation, when the eye shows no signs of glaucoma, when the anterior chamber is normal in depth, and there is no history of frequent attacks of misty vision with coloured haloes round lights—then it may be possible to abstain from operation. But in such a case the patient must be frequently tested with the tonometer to make quite certain that there is no occasional rise of tension. If I decide to operate I now perform what I call "trap-door iridectomy." I proceed as in a trephine operation: reflect the flap, split the cornea, and with a 1·5 mm. trephine cut a disc obliquely, open it on a hinge, and pull out the prolapsed iris and cut it off. I now shut the trap-door and suture the flap. In all my cases the iris has prolapsed. If it did not prolapse I think that rather than fish for it with forceps I would remove the disc and do without any iridectomy. So far this operation has yielded very gratifying results. As far as I can see it has no disadvantages and many advantages. In the first place the iridectomy is perfectly peripheral and may in consequence be limited in

breadth. There will be no dazzling and no obvious deformity. Again, there is no post-operative astigmatism and there is no danger of wounding the lens. The immense difficulty of operating with a very shallow chamber is avoided. In the classical operation there is, even in the hands of the most skilled, a real danger of a localised post-operative cataract. At one time, when I had never myself suffered, I thought that such a cataract was the effect of defective technique. I am now wiser, and I advise the younger members never mentally to criticise the skill of a colleague when they see a localised, perhaps traumatic, cataract under the coloboma of an eye operated upon for acute glaucoma. I feel certain that it is practically never due to the point of the keratome or Graefe knife. It may be due to minimal pressure of the forceps; in fact, in one of my cases it undoubtedly was so caused. The forceps were defective and had to be introduced three times before the iris was grasped securely. But in some cases it is difficult to explain. I have recently seen a case in which I performed my trap-door iridectomy. The iris prolapsed and no instrument was introduced into the eye. Yet under the coloboma, well away from the trephine hole, there was a localised cataract. I think that the capsule in these acute cases is very tenuous and perhaps the lens is tumid. The sudden reduction of tension may allow it to rupture. I throw this out as a suggestion, which may be comforting. I have seen a traumatic cataract in a case with a deepish chamber, in which the point of my keratome never went near the lens, and in which the forceps grasped the iris easily. Although I have, as I say, seen a case after the trap-door operation, yet I think it is far less likely to occur. I strongly recommend the conservative treatment. It avoids a general anæsthetic, and an operation upon an inflamed, engorged eye, under the worst possible circumstances.

And now regarding chronic glaucoma. I have picked out of my cabinet the history of the four last private cases of glaucoma simplex which I have examined. I have not

in any way selected them, but you will see that they all present the same somewhat unusual features. I am handing round the tonometric charts, the fields of vision and the scotoma charts. You will notice that in three of them there is no reduction of the field of vision, taken with a white 10 mm. square on the ordinary McHardy and Priestley-Smith perimeter. I daresay that with a smaller object and a more expensive perimeter there might be some contraction, but to the usual rough clinical test there is no change. In each case the examination with the Bjerrum screen shows the existence of a dangerous scotoma near the fixation spot. In one case it actually touches the central spot, and the patient when she looks at an object says that "it comes and goes." Here we have an eye with a clinically normal periphery and for practical purposes a normal field, and yet in a few months at most she will have lost her central fixation. The tension of the eye was 60 when I first saw her. She has used pilocarpine and it has fallen to 30 Schiötz units and there it remains. I propose to operate upon her at once, and Mr. Treacher Collins, who has kindly seen the case for me, recommends this course. I may lose the fixation, but I think not, and in any case I shall save the periphery.*

These cases show the absolute necessity of using the Bjerrum screen in both private and hospital work. It is a matter of five minutes at most to exclude such a scotoma, and I admit that they are not generally present; to map them out is a longer job, but it must be done, and done frequently. The reason is that in some cases these scotomata are noted on one examination and a week later may not be found. I am showing the charts of a case which showed a central scotoma one week, the next it was absent. A week later the same scotoma was mapped out by Mr. Priestley Smith, and later I detected it again. This patient has not visited me for some time, so I cannot say what the present condition is. We

* Later note.—This case has been operated upon with complete success. The vision has risen from $\frac{6}{60}$ to $\frac{6}{6}$, and the scotoma has diminished.

decided not to operate upon him because he had one normal eye, and the presence of a renal fistula contra-indicated any operation that could be avoided.

I wish now to urge the importance of the tonometer. I see my cases weekly, use the tonometer each time, and chart the result. At the end of the month I have a curve, and can see the result of treatment and judge of the necessity for operation. The examination takes less than five minutes. I instil a drop of cocaine, count ten, lay the patient down and take the readings. I have not yet had any intelligent patient object to such an obvious scientific procedure. The less intelligent must suffer as we all do for lack of intelligence. It is just now difficult to get holocaine and it is not as efficient as cocaine. In one of my patients, too, it always dilates the pupil. I use it when I have it, but really I prefer cocaine. I at once instil a drop of eserine and the pupil need not dilate. It is, however, often an advantage to get a slight dilatation to examine the macula more minutely. I do not doubt that there are men with more capable fingers than others, but I personally place little reliance upon mine. I want to know the exact tension from week to week. I want to be able to distinguish between 25 and 30, and I doubt whether any finger can do this.

My reason for urging early operation is that I find that when the operation is done early the result is good. During the past two and a half years I have trephined some fifty cases of glaucoma simplex. I have had no complications, and all have, as far as I know, done well. Many I have examined constantly, others have been lost sight of. In two cases I had to repeat the operation and the result was good. A certain number of cases develop cataract, but I have not noted this recently; it takes time. Since I replaced the 1·5 mm. trephine by the 2 mm. I have had but two cases in which the hole healed up. I do not find that the scar is more ectatic after the larger instrument. Finally, I have had but one example of late infection after trephining, and that a slight one. I believe

that if the operation be well done, under the most stringent aseptic conditions, late infection will be very rare.

6. *A modified operation for chronic glaucoma.*

By P. H. Adams (Oxford).

The operation which I have been doing recently for chronic glaucoma is adapted from several different operations. I claim no originality for it, and I daresay it is performed by other surgeons, but I have not come across any published description. The method is as follows:

(1) A large conjunctival flap is turned down, dissecting it in its centre part right up to and exposing the sclero-corneal margin; no splitting of this is required.

(2) A narrow keratome (the one I have been using latterly is about 3 mm. wide) is inserted into the sclerotic 2 mm. from the corneal margin and then pushed through into the anterior chamber and slowly withdrawn.

(3) A Herbert's bent knife is then inserted, first at one end of the incision and then at the other, making a lateral incision on either side, extending from the corneal margin upwards to the horizontal keratome incision; in this way a horizontal wedge is formed.

(4) By gently pulling on the conjunctival flap this wedge is tilted forwards, and as much of it as desired can be cut off with a pair of straight scissors. Iridectomy scissors answer well.

(5) A button-hole or complete iridectomy, as may be wished, is next performed.

(6) The conjunctival flap is then replaced and kept in position by a stitch.

The points in favour of this procedure are:

(*a*) I find it on the whole easier than trephining. There is no risk of losing the disc or of damage from the trephine cutting through unexpectedly.

(*b*) Entering the anterior chamber is a certainty without the trouble of splitting the cornea.

(*c*) The length of the incision may be graduated by using a longer or shorter keratome, and the amount of sclerotic removed from the flap may similarly be varied, as considered necessary.

(*d*) The resulting scar is not so likely to become unduly cystoid; filtration is spread over a line, instead of a circular hole.

The only difficulty I have encountered is cutting up the sides of the flap with the Herbert bent knife. This must be done as gently as possible.

The chief advantage is the ease with which one can vary the amount of sclerotic one removes.

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7. *Some points in the performance of the Lagrange operation for chronic glaucoma.*

By Bernard Cridland.

In coming before you to say anything on such a well-established and reputed operation as that devised by Prof. Lagrange some explanation of my reason for doing so is necessary.

Although it is the parent method by which fistulisation of the eye is obtained, it is not, as far as I can gather, the operation most commonly done in this country.

It is generally regarded as a difficult procedure, and for that reason trephining or some other method is preferred.

Having had some experience in performing this operation—for I have adopted it to the exclusion of all others for the past fourteen years—I wish briefly to go over the points in its execution, emphasising those which have been, and are, difficulties to me.

I do not wish in any way to compare it in its value to any other method or modification whereby fistulisation is

obtained, for this operation stands by itself, and I wish to speak of it and it alone.

The description of the operation is not in most text-books too clear, I think, and it is necessary to refer to the various original descriptions given by Lagrange himself in 1906 and since that year.

It is of course unnecessary to describe the operation in detail as it is so well known, but there are certain essential points Lagrange puts forward, and which must be referred to, for in them are to be found, I think, the chief difficulties of the operation.

Thus Lagrange says: "The puncture and counter-puncture are made as far back from the corneal edge as possible, though keeping the knife in the anterior chamber.

"The knife is made to cut upwards and backwards, and as it does so it must shave the base of the iris." Lagrange makes a great point of this shaving of the base of the iris, for therein lies one of the main points of the operation, and there is no doubt but that this is so.

Next comes, of course, the excision of the scleral wedge by means of the special scissors or other instrument as the case may be. Then the peripheral iridectomy is performed, and with the smoothing of the tissues into place the operation is complete.

Now to consider what may be regarded as the difficulties of the operation:

1. *The incision.*—The choice of the knife to be used is a very important matter. Formerly I used an old Graefe knife, worn and thin, but not whippy. If it is whippy it is almost impossible to make the counter-puncture, especially as, owing to friability of the conjunctiva, it is difficult to fix well an eye which is the subject of chronic glaucoma.

After visiting Bordeaux, where I had the opportunity of seeing Lagrange do the operation a number of times, I brought back with me some knives which were specially made for him by Luer, of Paris, and these, or copies of them, I have used ever since, with the exception that

I prefer them about 3 mm. shorter than the originals and a shade broader in the shank. This seems to be of sufficient length and quite free from any whippiness.

Before the operation it is extremely useful to use the transilluminator in the manner which was pointed out some years ago by Mr. Percival Hay, of Sheffield, for it shows how much distance there is from the corneal edge to the summit of the anterior chamber; this may not be exactly at the root of the iris, for the reason that, as is well known, this structure may be adherent to the anterior wall of the anterior chamber for a very short distance.

A knowledge of the space shown gives confidence in making the incision. In making the incision I suppose the chief fear in one's mind is lest it should be made too far back and the ciliary body be wounded—at least it is my chief fear.

If the knife is introduced at the points of puncture and counter-puncture as the diagram would seem to indicate, and the incision made exactly as shown, one does obtain an opening in the sclera which is almost alarming.

My plan has therefore been to puncture and counter-puncture just behind the limbus, *i. e.* in the bevel, and then causing the knife to cut upwards and backwards until the summit of the angle of the anterior chamber is reached, it can be seen to lie parallel to the plane of the iris. The knife-edge is then turned a little backwards and another cut made so that the action of "shaving the base of the iris" is accomplished. It is then that the thought may come that the section has been made too far back and the ciliary body is in danger of being wounded.

A momentary survey of the knife-blade in relation to the rest of the eye reassures one at once, and the process of cutting out through the sclera can be completed. I prefer to make the tongue of sclera a long one, for it gives plenty to hold with the sclerectomy forceps. The conjunctival flap is cut preferably as large as is conveniently possible.

The scleral incision which is obtained in this way does

not seem to be quite such an alarming one as the diagram suggests, and yet with it satisfactory results are obtained. The next step is to seize the end of the conjunctival flap and draw it down over the cornea—a procedure which causes the flap to cock up at right angles to the surface of the globe; it is now quite easy to cut off the scleral wedge with the scissors, and this is the method I formerly employed, although now I grasp the end of the scleral tongue with the small, specially-made sclerectomy forceps. The scissors must be of the correct curve and cut crisply.

The final step in the operation is the peripheral iridectomy. The base of the iris is seized, drawn gently out if it has not already presented, and the tiniest cut with the scissors gives one all the iridectomy that is necessary.

Sometimes I think I have not accomplished this, but when the repositor is used to smooth the iris into place one usually sees a beautifully neat V-shaped iridectomy at the periphery, and one is astonished at times how it comes about.

Lagrange advises in some cases, especially where the tension is apt to be high, to open up the suprachoroidal space with the repositor, and release a small collection of fluid which is sometimes present; this is easily done by slipping the repositor upwards beneath the posterior wall of the wound. The conjunctiva is replaced and smoothed over, and the operation is complete.

Usually neither mydriatic nor miotic is used. This is, of course, essentially an operation for simple chronic glaucoma, and for cases below 45, say, with Schiötz tonometer. If the tension is higher than this it aids the operation considerably to perform a posterior sclerotomy beforehand. I have never seen any harm come from this.

As to results, I have only very rarely found it fail to relieve tension altogether; usually it normalises the tension, but in some cases, although it is reduced, it is not reduced to normal, and the operation has to be repeated. One

word with regard to late infection. I have only knowledge of one case of mine in which this is said to have occurred, and the observation was made by another surgeon.

The case in question was one in which it would not have been a matter of surprise if both eyes had been lost from panophthalmitis.

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8. *Loss of vitreous in cataract extraction.*

By T. Harrison Butler (Birmingham).

Vitreous escape during cataract extraction does not appear to receive the attention it deserves from the authors of the text-books upon ophthalmic surgery. It would seem to be regarded as of trivial import by some, more especially by the devotees of the intra-capsular operation. Others regard it with greater respect, and find that even when moderate in degree the final visual acuity of the eye is apt to be poor, and that inflammatory complications are more frequent and severe. I have always looked upon loss of vitreous as a serious complication, and in order to obtain exact information as to the final effect I have looked up all the records which I have to hand. An examination of these cases confirms the view that I had formed, that eyes which have lost vitreous are more liable to suffer destructive irido-cyclitis, and that the resulting vision is considerably worse than that which follows normal extraction. In a word, loss of vitreous is greatly to be dreaded, and every precaution should be taken to avoid it.

I propose to consider the subject under the following heads :

(1) Comparative frequency of loss of vitreous.
(2) Comparative results of loss of vitreous.
(3) Causes of vitreous escape.
(4) Methods of avoiding vitreous escape.
(5) Treatment of cases when vitreous escapes.

(1) It is generally held that with reasonably good operating vitreous is not lost in more than about 6 per cent. of the operations. An analysis of my first 250 extractions in England showed that in the first 200, 5·5 per cent. lost vitreous, and that the next 50 operations gave 6 per cent. as the proportion. I therefore assume that my normal figure is 6 per cent. with the ordinary speculum operation.

Four patients behaved so badly that an anæsthetic was given and none of them lost any vitreous.

Sixty-four extractions performed in Jerusalem gave a percentage loss of 17. This figure, which is nearly treble the English proportion, is due to the fact that these patients had little self-control.

(2) *Comparative results.*—Little can be gained by the study of my Eastern cases, because the refractions were rough and cylinders were rarely ordered. The patients were in the main lost sight of. Two eyes of the 11 recorded were lost, and it would appear from the notes that both suffered from irido-cyclitis. This complication was very rare after a normal operation, in fact almost unknown. As far as the cases have any value for our purpose, they go to show that irido-cyclitis is more common after a vitreous loss than after a normal operation.

I have the notes of 24 cases operated upon in England in which more or less vitreous escaped, and I propose to compare the results obtained with those which were obtained in my first 200 extractions. These 200 cases include 11 which lost vitreous—a fact which weights the evidence against the uncomplicated cases.

As regards *acuity*, nearly 60 per cent. of my first series obtained $\frac{6}{12}$ or better. The figure for the vitreous escapes is but 25 per cent.

Total loss.—Six per cent. of the normal operations either ended up with practically no vision or the eye was removed. Those complicated by vitreous loss gave nearly 17 per cent. of lost eyes—in other words, escape of vitreous trebled the loss.

Panophthalmitis.—One eye was lost from panophthalmitis among the 24 losses of vitreous—a percentage of over 4. My figure for uncomplicated operations is a little over 1 per cent.

Irido-cyclitis.—Four eyes in the 24 were lost from this complication—about 16 per cent. The corresponding figure for the uncomplicated cases is 4 per cent., so iridocyclitis is multiplied four times by loss of vitreous.

Detached retina.—This was noted once in the 24 vitreous cases, and but twice in over 300 normal extractions.

These figures prove most conclusively the very evil effect of loss of vitreous.

The poor vision attained is in most cases due to a permanent haze of the vitreous with large floating opacities. In other cases the pupil is drawn up, and good vision is not always obtained after iridotomy.

(3) *Causes of vitreous loss.*—These may be grouped under three heads:

(*a*) Lack of dexterity in the operator.
(*b*) Abnormal conditions in the eye.
(*c*) Bad behaviour of the patient.

Operators vary in dexterity, and the same surgeon may operate with more or less skill at different times. Some men charm the lens out, others extract it, not a few express it, and a few paw the lens out. Probably the first three classes suffer from about the same percentage of vitreous loss, but a really bad operator will lose more than the rest. I think that the operator has less to do with the loss than the patient—a great deal less.

Some eyes are undoubtedly abnormal in the sense that the vitreous is fluid and the hyaloid membrane tenuous. There are other abnormalities perhaps connected with the hyaloid artery.

Two of my cases are instructive in this respect. Both were women and were excellent patients. Neither strained in the least. The section was made without any difficulty with a sharp knife. In both normal vitreous followed the section. I at once tried to extract with the vectis.

I have never before failed to remove the lens at the first attempt. In both these cases as soon as the lens appeared it slipped back off the vectis and was removed only at the third trial. In both a filament was seen to be attached to the edge of the lens, and it was this filament which became taut and pulled the lens off the vectis.

The all-important factor is the behaviour of the patient. Nine cases out of ten are not due to obvious faults in the operator nor to any abnormality in the eye, but simply and solely to a straining patient. If we wish to reduce our vitreous loss we must prevent straining or mitigate its evil result.

(4) *Methods of avoiding vitreous loss.*—These fall under two heads :

(*a*) Treatment of the patient before operation.

(*b*) Treatment during the operation.

I attach the greatest importance to what may be called the psychic preparation of the patient. To get the best results from extraction we must expose our victim to a suitable ophthalmic atmosphere.

I find that I lose vitreous in a considerably higher proportion of the cases operated upon at the Leamington General Hospital than I do at Coventry or at the Birmingham Eye Hospital. Why? At the Warneford Hospital, Leamington, the patients have been put into a general surgical ward. They have been nursed by excellent surgical sisters, keen and devoted, but with little or even no experience of cataract work. We have averaged but five extractions a year, and these five have been distributed among different wards.

The patients, fresh from homes more or less quiet and wholly familiar, have been pitchforked into the dreadful environment of a general surgical ward. Perhaps during the night preceding the operation they have lain awake shuddering at the groans of one or more victims of the general surgeon. A poor woman who has undergone partial evisceration or nephrectomy is no soothing companion for a cataract patient. Instead she should have

in her next bed a patient who has experienced the joy of being the subject of a work of art, painless, almost pleasureable—the modern extraction. Of late I have refused to operate upon patients who lie in a general surgical or even medical ward, and have had my patients in sidewards. Here indeed there is quiet of a sort, but we lack the atmosphere produced by the presence of patients who have been through the mill.

At Coventry I have the antithesis of Leamington. My patients are in ophthalmic wards, male and female. An experienced ophthalmic sister presides over the work, and bright ophthalmic children encourage their elder and more nervous companions. The sister not only tells the patients that they have nothing to fear, but she practises them by washing out the eyes and by introducing a speculum.

The children who have been operated upon tell the old ladies that they have nothing to fear. One of them said to a nervous old lady: "You need not be frightened, Granny; I have had several operations and I do not mind one bit." The result is that at Leamington I have to deal with nervous patients and the loss of vitreous is more than it should be, whereas at Coventry I had not lost vitreous for over two years till I began to employ Fisher's retractors, when I lost it in three successive operations! I am fully convinced that both from the standpoint of septic infection, and loss of vitreous, it is impossible to get consistently good results when extraction is performed in a general hospital too small to indulge in an ophthalmic ward. Mr. Cridland tells me that he has exactly the same trouble in another general hospital. An eye hospital occupies an intermediate position. From a nursing point of view it is a backwater, and in most cases the nursing is not so good as it is in an eye department attached to a general hospital. The junior nurses are keen and do their best, but they have not had the advantage of a general training with the discipline that it involves.

I am wholly opposed to operating upon drugged

patients. The influence which keeps them docile must be psychic and not chemical. A man under morphine is neither awake nor asleep and cannot be held wholly accountable for his actions. We need intelligent co-operation and complete trust in the operator. A nervous operator in some telepathic way communicates his mental state to the patient, and is not likely to get good results.

Treatment during the operation.—If the patient be obviously intensely nervous and shows at once that he is going to strain, it seems to me wise to use a general anæsthetic. I never allow any of my patients to have chloroform in any dilution because I know of so many fatal cases. I only just escaped one myself using one part of chloroform in sixteen of ether. I employ pure ether. I have extracted four lenses under ether anæsthesia without the slightest difficulty and with the ordinary upward section, and I shall have no hesitation in using it again in bad cases.

Loss of vitreous is so rare that I cannot think that it is necessary to divide the canthus as advised by some, or to inject cocaine into the orbit and over the branches of the facial nerve.

Shall we use a speculum or not, or shall we go even further and employ retractors? I have never tried operating without a speculum and I cannot see how eliminating the speculum avoids loss of vitreous. I once saw one of the most dexterous operators in the world extract without a speculum and he lost nearly all the vitreous!

During the past year I have been using a modification of Fisher's retractors. I find that they get in the way of the knife and there is a tendency to make a corneal section without a conjunctival flap. I have lost vitreous three times while using them. In one case the lower retractor slipped out and the lower lid snapped back upon the eye and vitreous escaped in slight amount. this led to a modification of the lower retractor. In the other two cases the patient strained badly, and, although

the lids were far away from the eye and could not possibly press upon them however much the orbicularis contracted, yet a slight amount of vitreous escaped. I think that it must have been caused by contraction of the recti muscles. I am not at all certain that the patient is not more likely to strain when these retractors are employed. They must be very uncomfortable and even painful. Another disadvantage is that a skilful sister or other assistant is necessary to hold the retractors. I still have an open mind, but at present my feeling is that the retractors do more harm than good. Probably in a really bad case they may save the eye from loss or restrict its amount.

(5) *Treatment of cases in which vitreous escapes.*—Much will depend upon whether a preliminary iridectomy has been done or not. I practically always do one. If there is an iris coloboma there will not be the same danger of iris prolapse, or if it take place, it will be small and confined to the angles of the wound. Another advantage is, that we have knowledge of the probable behaviour of the patient from our record of the previous operation, and also that there is less to do at the actual extraction, and so there is less time for the patient to lose control. Again, the iridectomy is the only part of the operation likely to cause pain. For these reasons among others I practise preliminary iridectomy, and shall continue to do so. If vitreous presents or escapes after the section I always extract the lens with Taylor's vectis, and at once close the eye with a bandage and do not look at it for forty-eight hours.

If vitreous follow the delivery of the lens I always close the lids at once and put on a bandage. I feel sure that any attempt to perform an iris toilet or to cut off the vitreous is a great mistake, and only leads to further loss. Fortunately in the majority of cases when the eye is dressed the wound is closed, and there is no iris in the wound.

When all is finished the iris may be impacted and the pupil drawn up. In these cases I perform iridotomy with

a Ziegler's knife. If the knife be perfectly sharp this operation presents no difficulty.

In conclusion I hope that I have shown that loss of vitreous is a dangerous complication, and that every precaution should be adopted to avoid it. Skilful and rapid operation and careful psychic treatment of the patient offer the best chance of success.

Mr. HARRISON BUTLER, in replying to the discussion which followed, said he agreed with Mr. Johnson Taylor that the cataract incision should be a large one. He had intended to emphasise this in his paper. He always advised beginners to commence the puncture at the semi-diameter, or within a millimetre of this spot. Then, if the incision were truly horizontal and the section comprised nearly half the cornea, no harm was done. If, however, as was not infrequent with the beginner, the counter-puncture was higher than intended, then the wound was still adequate to allow the lens to escape with ease, and there was less danger of vitreous loss. He personally aimed at a section which was horizontal and about a millimetre short of the semi-diameter at each end. As soon as the edge of the lens appeared he coaxed it out with the lens hook, and did not rely upon pressure. The less pressure the better, hence the value of the large incision and of the lens hook. He thought that a conjunctival flap was useful, but if it were not coming naturally he did not object to a corneal section. Mr. Lloyd Owen, who in his time was one of the most dexterous operators in England, deliberately made a corneal section, and his extractions would stand comparison with any. Dr. Lundogard, of Denmark, who was present at the Congress, had pointed out to him that the corneal section closes within a day, but under the flap it is a matter of three or four days before the scleral wound closes, although it is shut off from the outside by adhesion of the conjunctival flap.

He objected to the so-called intense cocainisation of the

eye, because it led to vomiting after the operation and to desquamation of the corneal epithelium. He agreed that a drop of cocaine should be put into the second eye, and he always did this. He strongly objected to chloroform, as he had said in his paper, and nothing that Scottish members might urge in its favour would move him from his position. He cited some of the deaths that had taken place in the hospitals to which he was attached. The danger was a real one, and he would expose none of his patients to it. He had had no trouble with vomiting. If the ether were administered by a competent man it was not likely to occur after the short anæsthesia necessary for an extraction. He had seen Hudson's retractors. He was not at all satisfied with Fisher's, and he would try Hudson's. He had once found it necessary to needle a secondary membrane after an intra-capsular extraction, which the negro patient achieved for himself.

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9. *Some points of interest in the work of a school oculist.*

By J. Hamilton McIlroy (Glasgow).

On the principle that everything which at the present time tends towards the furtherance of child-welfare is of vital interest to all of us, a short paper on the subject of ophthalmic work among school-children needs no apology, although I feel my contribution to this Congress will compare unfavourably with the work of the distinguished ophthalmologists who have come before me.

The work of school clinics contains nothing of a startling or dramatic nature, and our results, being the outcome of continued treatment and vigorous administration, are valuable in so far as they lead to improved physique on the part of the younger generation.

The activities of a school oculist fall into two categories, viz. (1) inspection, and (2) treatment.

The work of the school medical officer being intimately associated with the educational system, one sometimes has a little difficulty in urging treatment of minor ailments, the parents being inclined to look upon the medical staff as disciplinarians rather than benefactors, and the system as one of interference with the freedom of the community. A patient suffering from an acute or well-defined complaint will seek advice voluntarily, but when urged to take steps in regard to the cure of ailments which to the uneducated intelligence do not exist, difficulties arise.

Parents call attention to the presence of similar defects in their own persons, which have been present since childhood, and have led to no evil results, and it is difficult to persuade these parents that such defects are a handicap and should be rectified in their children. With the passage of time, however, school medical inspection and treatment have come to be regarded as inevitable if not desirable, and opposition has melted almost to vanishing-point.

In no department of school medical work is there more prejudice to contend against than in that of refraction. Many children who suffer from gross refraction errors are unaware of the fact, at all events in the early years of school life. Glasses are an expensive item in the upkeep of a heedless child, and many children complain that by wearing glasses they become subject to ridicule amongst their school-fellows. It is only by gaining the confidence of the parent, and co-operation on the part of the teacher, that such cases can be successfully reached.

It is therefore of great importance that there should be a reliable system of *inspection*, whereby genuine errors of refraction may be detected and urgency for treatment indicated.

1. Inspection.

In Glasgow the Education Authority has a system of routine eyesight inspection which has been in practice for about 15 years, and has considerable advantages.

Under this system every infant is examined by retinoscopy as soon after admission to school as possible, in order that no visual abnormality may be undetected.

Each school is visited once a year by the oculist, when all newly-admitted infants, and all children of the junior, senior and supplementary classes who have failed to pass the teacher's test (*i. e.* vision in either eye = $\frac{6}{9}$), are presented for examination. Boys and girls of the classes above the infants are taken in alternate years.

Due notice of the oculist's visit is sent to the head-master of the school to be visited, and the lists are then prepared. The equipment necessary for the examination is as follows: A class-room or teacher's room, well darkened; a small table and three chairs; a small paraffin lamp, with suitable shade; a Wright-Thomson skiascope. One teacher sits at the table and acts as clerk. The children are marched in a line in front of the oculist, who sits at the table, and a senior child sits at the opposite side, and assists by covering alternately the eyes of the child who is being examined. Another teacher stands behind the oculist and attracts the attention of the child by holding up fingers, in order that accommodation may be eliminated as far as possible. The results of the retinoscopy of each eye are duly noted on the list, and a mark is entered opposite each child who is found to be urgently in need of attention.

Cases showing hypermetropia over 4 D. or astigmatism of 3 D. and all cases of genuine myopia are notified. All forms of squint (hitherto untreated) and suspected fundus lesions are included. Much information may be obtained from the teacher in regard to the child's visual acuity in class-work.

Due notice is sent to the parent informing him of the presence of the defect thus discovered, and offering treatment in necessitous cases.

Cases which show the lesser degrees of refractive error are not as a rule dealt with at this inspection, but may be presented from time to time as non-routine cases. Obvious

conditions of eye disease, such as may be detected at ordinary medical inspection, are not included.

In this way inspection by retinoscopy acts as a sieve for the grosser degrees of refractive and fundus abnormality, and a considerable amount of pressure can be brought to bear in enforcing attention to treatment. Where this form of inspection is not in use it comes to pass that the selection of defective children rests almost wholly on the teacher, and transient conditions such as conjunctivitis (which give rise to blurred vision for a time) are duly presented to the oculist for refraction at a later date when normal vision has become restored. Valuable time in this way is wasted, and more urgent cases may be overlooked. During the year ending July 31st, 1920, the number of schools in Glasgow visited by the oculist for this form of inspection was 88; over 20,000 children were examined, and of these about 12 per cent. were found to be seriously defective and in need of immediate treatment.

The drawback of the system is that it takes up a large part of an oculist's time, and the work is not such as can be relegated to a junior. Retinoscopy without mydriasis must be carried out by an expert to be of any value; but time is gained in the long run, in that the clinics are not blocked with unsuitable cases.

2. Treatment.

Refraction.—The child having been scheduled as defective, and if qualified by circumstances as necessitous (practically all children may receive this form of treatment from the Education Authority), the parent is summoned to attend with the child at the nearest clinic on a specified date. A nurse is in attendance at the hour named, and she applies atropine lamellæ (B. W. & Co., $\frac{1}{200}$ gr.), one in each eye. The oculist is due half an hour later, when mydriasis is usually complete.

As a rule one examination is sufficient, and glasses are prescribed at the first visit; but if mydriasis be not satis-

factory or further examination without mydriasis be necessary, the child is asked to return on a date, of which notice will be sent to the parent.

For some weeks past a controversy has been taking place in the pages of the *British Medical Journal* on the subject of refraction work among school-children, and the relative value of the subjective and objective methods of correcting errors of refraction. The exigencies of school medical service demand the use of methods which combine efficiency with the greatest possible speed, and, owing to the somewhat exhausting nature of continuous refraction work, an appropriate limit must be set upon the length of time occupied by each daily session. It is therefore impracticable that the minute care recommended by some authorities should be given to the subjective examination of each child, however much satisfaction one might have in verifying one's objective findings. My own working plan is to attack every case with sufficient attention to the retinoscopy to ensure that if the subjective tests break down, I nevertheless shall have confidence in my results. Mydriasis therefore must be very complete, and the retinoscopy accurately gauged.

I use a plane mirror (Hawes, London), 4·5 cm. in diameter, and a central opening 4 mm. in diameter. Each clinic is provided with a full set of trial lenses and a 3-cell trial frame. Illumination is furnished by a bracket lamp with jointed arm, movable in all directions. When the clinic is held in a school which is not a regular centre for treatment a portable "kit" is used, consisting of the trial lens outfit and a table-stand, to which its gas or electric lamp can be fitted according to the lighting of the school in question.

My method of testing is as follows: In a case of hypermetropia I note the lens that just *reverses* the image; in compound astigmatism I find the lens which turns the image in the meridian of lower curvature, and note the axis; with this lens in place I add spherical lenses of increasing power, until the one is reached which reverses

the other meridian. The second lens is then removed, and a *cylinder* of the same power is placed in the position which has been judged to represent the axis. If the axis be not accurate the streak of light is seen to be deflected to the opposite side, and the lens must be carefully turned until the axis of the streak becomes vertical or horizontal, or becomes equally distributed in all directions. It often happens that on placing the cylinder in correct position the meridian of lower curvature shows a little more hypermetropia than was originally calculated, and one adds 0·25 D. or 0·5 D. convex sphericals until this has been obliterated. If one suspects that one has gone too far with the correction, the addition of a —0·5 D. sph. or even —0·25 D. sph. restores the balance. In the case of myopia I work with weak concave lenses until the one which just *neutralises* the image is reached. In myopic astigmatism I use the same method as described for hypermetropia, but I am very careful to keep within the point of reversal. When I have found the lenses which neutralise the image, I cautiously add weak concave sphericals until the image becomes definitely *reversed*, and then work down with weaker lenses till the point of neutralisation is again reached, when I compare the findings: if there is discrepancy between them the correct refraction probably lies midway between the two. In the case of mixed astigmatism I estimate the amount of hypermetropia by means of a convex spherical, and judge the axis; I then place a cylinder in position, and note whether the hypermetropia is fully corrected or requires the addition of a stronger cylinder. I remove the plus lenses, and the minus element is worked out in the same way with precautions against over-correction as noted above.

By this method one can obtain a very accurate estimate of the refraction, *provided mydriasis be complete*. When retinoscopy is satisfactory, there should be no risk in prescribing straightway for any case of well-marked error. In the case of school-children one is usually dealing with

errors of considerable degree, and although it is of interest to see the results attained when the child is tested subjectively, one would not place undue dependence upon the visual acuity by the help of glasses in a trial frame during a short interview were these glasses at variance with the retinoscopy. The real test of a successful prescription is that of good vision maintained over a lengthy period of time, the teacher being the judge both in regard to ordinary class-work and the reading of Snellen's types (the latter test being carried out before the oculist's annual visit to the school).

It cannot be said that there is any definite age at which subjective testing becomes reliable in school-children. I attempt the test in children of 7 years and upwards, and I have met with children of 6 even in whom the ordinary test was possible, whereas, on the other hand, children of 10 or 12 may be quite hopeless. In older children who suffer from ciliary spasm, as, for example, girls of the Supplementary Department who are the victims of asthenopia without any marked degree of refractive error, subjective examination is essential, and is usually of much value.

With regard to prescription in cases where no subjective test is available, I generally deduct 2·5 from my figures for hypermetropia, and add 0·5 to those found for myopia. Children usually accept full correction for astigmatism, but I keep within my figures by about half a dioptre.

The problem of prescribing glasses for squint where the ametropia is slight and the parent averse to glasses for the child is difficult. Where the ametropia is pronounced one finds the parent gives in more readily to the chances of improvement of the squint by glasses. When the squint is marked, the parent is instructed to cover the glass of the non-squinting eye for two hours daily. Unfortunately it is not possible to have systematic investigation of the progress of squint cases at stated intervals after glasses have been provided. Parents are instructed to bring the child to have the glasses checked at the clinic,

but even this provision does not always meet with the desired response. The question of following up cases in which glasses have been prescribed rests to a large extent with the teacher, who is expected to report to the school medical officer or to the oculist at the next yearly visit. The prescription is given to the parent immediately after examination, and may be presented to the Education Authority for endorsement, whereby the parent is enabled to obtain the glasses (from the optician appointed by the Authority) at a reduced cost, or in necessitous cases free of cost. I find that although there is seldom any fault to be found with the lenses supplied by the optician, the provision of a suitable frame is a different matter, and I have often to send a child back to the optician for a re-adjustment of the frame, which will mean everything to the success of the glasses when worn.

Children readily knock their glasses out of shape, and for this reason as well as that of the greater cost of cylinders I hesitate to order weak cylinders for a child of the poorest class. I do not recommend large round glasses as being more likely to make the child look directly through them; if the frame be comfortable and the lenses suitable, I do not find the child looks over the glasses. I do not remember any case that has been presented to me for revision in which any important change had to be made in the prescription, although many require re-adjustment of the frame. I am convinced that a child will bear incorrect lenses much more gladly than a frame which gives him discomfort.

I have dwelt at some length on the subject of refraction, partly because it is the branch of work which fills most of the time of the school oculist, and partly because it is the most interesting.

The treatment of ordinary ailments met with in the eye disease clinics can be carried out by the ordinary school medical officer, and it is only in order to vary the work that the whole-time oculist has time allotted to such treatment. Special consultation clinics are held at frequent

intervals for the investigation of the more serious types of cases, and for children who require special educational methods.

The bulk of cases met with at the ordinary clinic are those which are to be seen in the outdoor department of any of our eye hospitals, viz. blepharitis, conjunctivitis, keratitis (phlyctenular and interstitial), corneal opacities, hordeoli, Meibomian cyst, cataract, trachoma, and to a lesser extent iritis and fundus lesions.

Chronic blepharitis occurs in our slum children to an amazing degree, and is no doubt associated with poor conditions in the home life.

I have found very striking results from the use of methylene-blue (1 in 1000 in saline), applied by the nurse at the clinic twice a week, or daily in severe cases. In addition to this the ordinary home treatment (alkaline lotion and yellow oxide ointment) are prescribed, but the cases in which the affection is most severe are those of poor homes and careless habits, and treatment is often confined to that given at the clinics.

Strumous conditions also are very common, and recurrent attacks interfere with school progress. I append a sheet which I drew up for the guidance of the parent in regard to the feeding of such cases, and it is regrettable that a closer supervision of the home hygiene and feeding of these children cannot be obtained, as one might then attack the evil at its source.

Acute catarrhal conjunctivitis and folliculosis are rife periodically, and rigorous exclusion from school for these affections is insisted upon. Trachoma is not common, but occasionally occurs. The disease is notifiable in Glasgow, and the cases are treated by the sanitary authority. As a rule these cases clear up very well, leaving little trace in the cornea. Interstitial keratitis is not a common condition in the ordinary clinic. I have had several cases, which I submitted to Dr. David Watson (at the Venereal Clinic, Central Dispensary), who found a positive Wassermann, and treated the children by injections, with very marked

results—the corneæ becoming clear, and vascularisation disappearing within a few months of the first injection.

The number of cases in which any history of ophthalmia neonatorum can be made out is small, and one forms the opinion that, judging from the information at our disposal, the occurrence of eye defects directly traceable to venereal disease is insignificant among Glasgow school-children. A systematic investigation, by means of the Wassermann and other tests, would be required to settle the question of the ætiology of the defects met with. We meet with many cases of nystagmus, but it is rare to be able to obtain any history of ophthalmia neonatorum even on careful questioning.

Choroiditis, when met with, is usually of the myopic variety; retinitis pigmentosa is a rare condition.

The education of the blind and semi-blind is of great importance, and the industrial efficiency of a defective-sighted person will be greatly enhanced by suitable training and care during school life. Although the numbers of actually blind in Glasgow are small, there are large numbers who suffer from impaired vision due to high myopia and other causes. Myope classes were first instituted with us in 1915. We have three myope centres; in one of these the children are given oral instruction with the normal children, but have the other work in a specially-fitted class-room. In the other centres the work is carried out wholly in the special class-room.

The children who are blind or almost blind are taught in the blind classes in connection with the ordinary school, and receive oral instruction with the normal children. Their special training consists in Braille, geography by maps in relief, with typing, basket-making, twine-work, etc., on the lines of an institution for the blind.

We have a hostel for the blind in the suburbs of Glasgow, the children being taken to and from school under the care of an escort.

Much is being done for the education of the blind, but

the true secret of cure lies in prevention. The Ministry of Health, by the institution of an investigation into the causes and prevention of blindness, may go far towards healing the sight of the community, but I plead for recognition of the part that is being played in a less conspicuous way by the school medical service.

Education Authority of Glasgow.

Instructions regarding the care and feeding of children suffering from eye diseases.

All discharge from the eyes is liable to infect others. The patient should therefore be provided with his or her own towel, soap, pillow, etc. Attention to the state of the skin is most important. A hot bath at night is of great benefit. Clothing should be warm, light and loose. Sleeping rooms should be well aired, windows being kept open as much as possible, without giving rise to a draught.

Diet.—It is of utmost importance that the child's diet be strictly regulated. There is a tendency to eat too much and too often, and the food is frequently of the wrong kind, so that the stomach becomes overloaded with indigestible substances and does not receive the rest that is needed between meals. Meals should therefore be given at regular hours. Food should not be given at other times, even to pacify a fretting child. A little water may be given for this purpose. When eye treatment is commenced, for the first forty-eight hours the child should be given milk and water only (a cup of hot milk every three or four hours). After the second day light diet may be given in gradually increasing quantities.

The following articles of diet are specially recommended:

Milk and milk puddings (rice, sago, cornflour, macaroni, semolina, junket, etc.)

Eggs (light-boiled, poached, scrambled).

Bread and butter, rusks.

Porridge.

Cream.

Gruel.

Fish (boiled, baked).

Soup (clear), beef-tea.

The following foods are very harmful, and should be forbidden:

Pastry, sweets, sugar (in all forms), potatoes, sausages, pork, bacon, cheese, nuts, tea and coffee).

MIDLAND OPHTHALMOLOGICAL SOCIETY.

1920–21.

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REPORTS.

Five meetings held during the year, three in Birmingham and two in the neighbouring towns.

I. A case of *Filaria loa*.

By T. Harrison Butler.

Some months ago I was consulted by a medical man who, when in the African Service, had become infected with *Filaria loa*. The infection had taken place fifteen years ago, and since then seven worms had been removed from various parts of his body.

On examination I was able to see the parasite wriggling under the conjunctiva. My patient knew better than I the best method of removing the worm, and he urged me to hurry and to be careful, otherwise the worm would, he

said, take fright and disappear with great rapidity. I cocainised the eye and seized the intruder with fixation forceps through the conjunctiva. I then passed a silk thread through the conjunctiva under the worm, and drew it tight. I now had it firmly fixed and escape was impossible. An incision was now made round the suture and the worm drawn out. Unfortunately it got cut in the process, and I had some difficulty in removing the second half. The organism was about an inch and a half long, and in form and texture exactly like a violin E string. Each end was tapered to a point. I can only find three allusions to *Filaria loa* in the volumes of the *Ophthalmoscope* and the *British Journal of Ophthalmology*.*

De Milly (*l'Ophtalmologie Provincale*, August, 1905, ii, p. 73) removed a *Filaria loa* from the eye of a missionary from the Congo. It was 6 cm. long and had made its appearance several times daily beneath the conjunctiva, where it caused considerable pain. It could be seen moving under the conjunctiva.

Paul Petit (*Ann. d'Oculistique*, May, 1911) gives the histories of two cases. In the first the patient, six months after his return from the Congo, saw a worm wriggling about under the skin at the bend of the right elbow. Eight years later a worm appeared under the conjunctiva of the left eye. It was seen under the conjunctiva or under the skin of the lids on and off for eight months, till, finally, Petit removed it. Six months later a similar worm was taken from the right eye.

In the second case under the care of Morax, a man who had contracted filariosis in the Soudan felt an irritation in his eye and went to the Lariboisière, where a worm was removed from under the conjunctiva. This was identified as *Filaria loa*.

Brunetière (*Annal. d'Oculistique*, August, 1913) records the case of a man who had a *Filaria loa* under his conjunctiva, and who, in addition to craw-craw and calabar

* See also this volume, p. 514 (Ed.)

swellings, suddenly developed hemiplegia, from which he recovered completely. The author considers that this paralysis was caused by a blocking of the terminal branches of the sylvian artery, possibly by an adult worm, but more probably by a mass of microfilia.

2. *Melanoma of the iris.*

By N. C. Ridley.

Mrs. A. K—, æt. 49 years.

L.E.: Pigmented mass in the angle of the anterior chamber down and in, 3 mm. × 1·5 mm.

R.E.: Normal.

She was first seen in March, 1912, when patient stated that it had been there since birth. Maternal grandfather had albinism and nystagmus. It has remained absolutely unaltered up to present date. Vision of each eye separately $\bar{c}$ gls. $(+2$ D. sph. $+ 0{\cdot}5$ D. cyl. a. v.$) = \frac{6}{6}$.

I showed a similar case at the Oxford Ophthalmological Congress in 1913, the notes of which are as follows:

Rev. H. O. H—, æt. 37 years.

L.E.: Brown mass 3 mm. × 2 mm. in the angle of the anterior chamber down and in. Noticed since childhood. May have slightly increased in size, but not definitely so. Contracted pupil slightly drawn towards mass. Iris movements limited in its neighbourhood. Nothing else wrong in fundi nor media.

R.E.: Normal.

Vision of either eye separately $= \frac{6}{5}$ Hm. 0·75 D. Recent report says, unaltered or perhaps slightly larger.

I had a third case at the Leicester Royal Infirmary at about the same time (1912), but, unfortunately, cannot find the notes. It was a woman of late middle age. The left eye was affected, the mass being down and in and of about the same size as in the other two cases. It had

always been there so far as she could say. Unfortunately she was very ill and could not be troubled by being made an exhibition of. She was suffering from acute albuminuric neuro-retinitis with hæmorrhages, and died of Bright's disease a month or two later. Unfortunately I did not hear of her death in time to try to secure the specimen.

Two of these patients had been advised by more than one ophthalmic surgeon to have the eye removed for melanotic sarcoma. In my opinion the growths are benign, being merely a hyperplasia of the epithelium of the original optic cup, at the point of closure of the choroidal fissure, in every instance the mass being in that situation. Each had a history dating from early life, none of them had definitely increased in size nor was there any sign of glandular affection, and the eyes were normal in other respects, except in the case with neuro-retinitis, which was of entirely independent causation.

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3. *A case of cyst of the iris.*

By T. Harrison Butler.

Malcolm E. F—, æt. 1 month. When the baby was a fortnight old the mother noted that the right eye was unusual in appearance. There is no history of any accident.

In the upper part of the anterior chamber there was a smooth globular swelling, having the exact appearance of a dislocated lens.

Examination with the loupe showed that it was covered with fine branching vessels. The swelling, which was obviously a cyst of the iris, half covered the pupil, and the mother said that it altered its position. The child was first seen on March 30th, 1921.

On April 22nd the child began to suffer pain and slept badly. She again came to the Coventry Hospital on April 25th.

The appearance of the eye had now completely altered. The cornea was œdematous, and it was difficult to get a good view of the contents of the anterior chamber. The cyst had flattened down and the upper aspect was covered with blood. The tension was not raised as tested with the finger.

On April 27th the child was anæsthetised with ether and a better view obtained. The cornea showed a superficial haze and a deep striation. The cyst had burst, and there was some blood in the anterior chamber, chiefly upon the upper part of the cyst.

Fig. 81.

Cyst of iris.

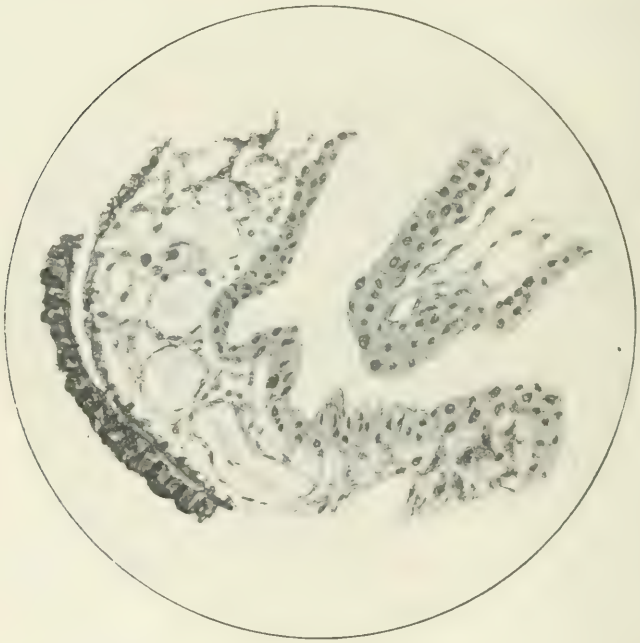
A large incision was made with a keratome and the whole cyst grasped with iris forceps. It was drawn out entire and cut off with iris scissors. A coloboma remained, just as after an ordinary iridectomy. The wound healed well, and the eye remained free from injection. May 23rd: The eye is free from any injection; the anterior chamber is somewhat shallow. There is a minute iris-encleisis. The tension is not raised, the cornea is still slightly hazy.

The cyst was sent to Mr. Treacher Collins for examination, and subsequent [illegible] September, 1921. The anterior chamber has deepened, the pupil is round and [illegible] dilatation has been advised.

tion, and he has very kindly sent me the following description, with a drawing (see Figs. 81 and 82):

"The drawing shows a typical piece of the two walls of the cyst. The cyst having collapsed before removal, the two walls in parts of the section have become entangled, and are not easy to differentiate. The part shown in the

Fig. 82.



drawing gives a clear indication of their relations to one another. On the left-hand side of the drawing a piece of iris-tissue is shown, lined posteriorly by its two pigment layers. In the stroma of the iris the blood-vessels are shown much dilated and on its anterior surface is an epithelial lining, consisting for the most part of two and sometimes three layers of epithelial cells. This doubtless was part of the lining membrane of the cyst on its posterior surface. Towards the right-hand side of the drawing

there is a piece of tissue with a similar epithelial lining, which I take to be part of the anterior wall of the cyst. On the external surface of this epithelium, *i. e.* away from the cavity of the cyst, there are some loose strands of fibrous tissue supporting blood-vessels. The epithelium lining the cyst bears much resemblance to the epithelium of the ocular conjunctiva, and looked at from the point of view of the pathological findings the cyst would appear to be an implantation cyst, due to the introduction of some of the epithelium of the conjunctiva into the iris.

"Against this view there is the fact that the cyst was noted when the child was a fortnight old and that there is no history of any perforating accident."

4. *Tear of inferior rectus by a cow's horn.*

By R. Beatson Hird.

A girl, æt. 15 years, had her left eye injured by a cow's horn. The lower lid was torn on the conjunctival surface and the inferior rectus was lacerated at its attachment to the globe, resulting in a marked upward squint. The upper lid was severely torn near its inner extremity, and this was sewn up, but as there was considerable sepsis no further treatment was undertaken until five months later; the inferior rectus was then sought and re-attached to the globe, and the superior rectus tenotomised. The result was restoration of movement and abolition of the diplopia. The vision was normal in both eyes.

5. *A case of acute retro-bulbar neuritis.*

By R. Beatson Hird.

The patient was a male, æt. 21 years, who attended the Eye Hospital on September 6th, 1920, complaining of sudden loss of sight in his left eye, vision being perception of light only. The pupil reacted consensually only, there being no response directly to light. The optic disc

appeared to be a little congested. The field showed a very large central scotoma, which was absolute, and extended to the periphery, the white field being horse-shoe-shaped. The right eye was normal except for myopic astigmatism, and vision was $\frac{6}{12}$ with correction. The pupil did not react consensually to light.

No nasal sinusitis was found. A Wassermann test was negative. X-ray photograph of orbit showed nothing abnormal, and no cause could be found for the condition.

September 9th: Definite optic neuritis with vision improved to counting fingers. The scotoma was less, and the gap in the periphery of the field now filled in, the white field being ring-shaped.

September 20th: Optic neuritis almost gone and vision $\frac{6}{18}$ partly, with correction for myopic astigmatism. The absolute scotoma had disappeared, but there was a small relative scotoma.

October 4th: Vision $\frac{6}{12}$ with correction and no relative scotoma. Fundus normal.

6. *A case of disseminated sclerosis.*

By R. Beatson Hird.

The patient was a female, æt. 40 years, an example of the apoplectiform type of disseminated sclerosis. Her history was as follows:

She lost the sight in her left eye eight years ago, and it made a complete recovery. Two years ago she had diplopia and right hemiplegia, which recovered completely. Towards the end of May, 1920, a mist came over the right eye. She was first seen by me on June 17th, when her right vision was $\frac{6}{36}$, and could not be improved with a glass. There was a central colour scotoma. The left vision was $\frac{6}{9}$. Both fields showed some contraction.

October 5th: Right vision now is $\frac{6}{6}$ part with correction. There is a very small central scotoma for green. The fundus has been normal throughout.

7. *A case of exophthalmos.*

By R. Brudenell Hulbert.

The patient was a male, æt. 65 years, complaining of protrusion of the right eye for about seven months, some diplopia, but no pain. There has been a swelling over the right parotid for thirty years following a blow. The facts of his case are as follows:

Right vision is $\frac{6}{24}$, and not improved with a glass. The left vision is $\frac{6}{9}$. There has been an ulcer on the lower part of the right cornea. The right eye is proptosed directly forwards 10 mm. in front of the other eye. There is only slight limitation of movement laterally. X-ray photograph shows nothing pathological in the orbit or accessory sinuses. Nasal examination negative. Wassermann test negative. Urine normal. The peripheral fields are full, but there is a slight vertical enlargement of the right blind spot and no central scotoma. The right optic disc is a little indistinct and pale. The ophthalmic division of the fifth nerve is not impaired.

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8. *A specimen of hypernephroma of the orbit.*

By R. Brudenell Hulbert.

The eye was removed from a male patient, æt. 41 years, admitted into the General Hospital, Birmingham, on October 24th, 1917, suffering from cough, expectoration of blood, loss of weight, and night sweats. He was stated to have iritis in the left eye. The diagnosis was phthisis.

The physical signs consisted of dulness over the front of the chest and in the scapular region, with bronchial breathing. There was a pleural effusion containing blood and cells, which were suspicious of malignancy. No tubercle bacilli were found and no organisms cultivated. Mr. Brudenell Hulbert was asked to give an opinion on the left eye on November 6th.

The left eye showed marked engorgement of the vessels on the globe and some definite proptosis. There was extensive detachment of the retina, and a large mass, yellowish and vascular, projecting into the vitreous. The tension was a little increased. There was a partial paralysis of the third nerve. The diagnosis of neoplasm rather than tubercle was suggested. The patient was too ill to be operated upon, and died on November 11th, 1917.

The left eye was removed at the post-mortem, and now shows a mass of growth surrounding the globe posteriorly and extending into the vitreous through the choroid, with detachment of the retina. This was examined microscopically, and diagnosed as hypernephroma before hearing the result of the general condition found post-mortem. This showed hypernephroma with extensive secondary deposits in the lungs and heart. The section of the globe shows the typical structure of such tumours.

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REPORTS.

Meeting held at Manchester, October 22nd, 1920.

1. *Report on a case of optic nerve tumour.*

By T. MILNES BRIDE (Manchester).

(With Plate XI.)

M. B—, aet. 2 years 9 months, a healthy and well-developed female child, was first seen by me in April, 1920, in my out-patient clinic at the Manchester Royal Eye Hospital.

The history given was that, just before Christmas, 1919, the parents noticed that the left eye was "bulging." This, they stated, was slowly and steadily increasing.

Both parents are healthy, and there is no consanguinity.

On examination I found that the left eye was to some extent proptosed, and also slightly divergent; movement in every direction was good.

The pupils were equal and responsive to light, but the reaction of the left was definitely sluggish.

The eye could only be reduced into the orbital cavity to a small extent, no mass or swelling was anywhere palpable in that cavity.

Ophthalmoscopic examination revealed a marked swelling of the left nerve-head—"choked disc." I was unable to estimate the amount of swelling, as the child was intolerant of examination.

As regards the occurrence of pain, this appeared to be entirely absent. The mother stated that the child never complained or cried.

It was impossible to obtain any positive evidence of loss of sight or otherwise owing to the youth of the patient.

Intra-nasal and X-ray examinations revealed nothing abnormal, and the Wassermann reaction was negative.

The right eye was healthy in all respects.

A diagnosis of tumour of the optic nerve was made, and concurred with by my colleagues.

On May 3rd, 1920, under open ether given by Mr. Gordon Renwick, I excised the eye and tumour. The procedure adopted was as follows:

After separating the conjunctiva and dividing the muscles the finger was passed behind the eye, and a large sausage-shaped swelling was found to occupy the position of the optic nerve. This extended right back to the optic foramen, thinning down towards it. I separated all round the tumour with blunt scissors, and after completely freeing it cut it off as far back as possible by pulling the eye well forward. No conjunctival sutures

Fig. 1.

Fig. 2.

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PLATE XI.

Illustrates Mr. T. Milnes Bride's Report on a Case of Optic Nerve Tumour (p. 459).

FIG. 1. Shows the microscopical appearances of the tumour.

FIG. 2. A section through the tumour and the eyeball, showing the relations of the two.

were put in, as the manipulation had been rather severe. The child was rather shocked, but recovered rapidly, and the socket healed well.

I saw the patient last month, just a year after operation. The socket is perfectly healthy, without any sign of recurrence. The child is well, and wears a satisfactory artificial eye.

Pathological Report.

I am indebted to Prof. H. R. Dean, Honorary Pathologist to the Hospital, for the following report on the case:

"The Museum preparation shows an oval white tumour about $1\frac{3}{4}$ cm. long and 1 cm. wide (see Pl. XI, fig. 2). It is limited externally by a white, dense connective-tissue sheath, which represents the dura mater.

"The cut section shows a central oval white area surrounded by an outer zone, which has a slightly brown tint. The outer zone represents the subdural space, the inner the enlarged optic nerve.

"The subdivision of the tumour is seen more clearly in the section stained by van Gieson's method. Here the tumour is seen to consist of two distinct portions separated by a pia arachnoid membrane.

"*Section stained by van Gieson's method.*—The tumour is limited externally by the dura mater, which is continued forwards until it fuses with the outer coat of the eyeball. The space between the dura and the pia mater is occupied by wavy strands of adult connective tissue, which form a loose reticulum in the subdural space. Within the sheath of the pia mater, that is to say, in the region of the optic nerve proper, the tumour is divided by strands of longitudinally arranged connective tissue, which correspond to the direction of the nerve-bundles within the optic nerve. Enclosed and supported by this reticulum of adult connective tissue are found the cells of the tumour.

"The type of cell is that which is found in a cellular

fibroma. The cell is spindle-shaped, with a spindle-shaped nucleus. The cells are arranged in strands and bundles, and as these bundles have been cut at various angles in the section the nuclei present every variety of shape (Pl. XI, fig. 1).

"*Section stained by hæmotoxylin and eosin.*—The finer details of the structure of the tumour-cells are better seen in this section. The bundles in which the tumour-cells are arranged follow in direction the direction of the intersecting septa derived from the pia arachnoid membrane. The nerve-bundles appear to have undergone atrophy."

Conclusions.

The tumour is an intradural tumour arising from the connective tissue of the dura and pia arachnoid. It consists of two portions, which occupy the region of the optic nerve and the subdural space respectively. The cells are fibroblasts, and the microscopical appearances are those of a cellular or soft fibroma. The tumour has presumably arisen from the connective tissue of the pia arachnoid membrane. The microscopical appearances do not indicate malignancy, but the extremely cellular character of the tumour suggests that growth might be relatively rapid.

The condition is similar to that described by several authors as neuro-fibromatosis.

Summary.

Primary intradural tumours of the optic nerve are rare.

Byers (1) states that the prognosis is a fairly serious one. He says: "The danger is not from recurrence in the strict sense of the term, but from the continued development of the intracranial portion of the tumour, which it is impossible to remove at the time of the operation."

In this case the nerve passing through the optic foramen was distinctly thickened, therefore the tumour

could not be completely excised. There is, however, no sign of recurrence after one year.

I recollect in 1909 that my colleague, Dr. A. Hill Griffith (2), operated on a case which was clinically absolutely similar to this one. He performed a complete removal of the orbital contents. His patient is alive and well to-day, twelve years after operation, and in his case he was unable to secure the whole of the tumour.

I adopted the operative procedure above mentioned, as the cosmetic result is much better than after an exenteration of the orbit. With careful dissection the tumour can be removed right back to the foramen. The artificial eye worn by this child is quite satisfactory.

References.

(1) Byers.—*Studies from the Royal Victoria Hospital, Montreal*, vol. i, No. 1, August, 1901.

(2) Griffith, A. Hill.—"Three Cases of Optic Nerve Tumour" (Case 2), *Transactions of the Ophthalmological Society of the United Kingdom*, vol. xxxi, 1911.

2. *Scintillating crystals lining the walls of an anterior chamber.*

By J. Gray Clegg (Manchester).

John B—, æt. 13 years. Seen October 14th, 1918: Vision of left eye poor, sometimes divergent. Has had several blows on forehead. V. = fingers, but field good. Left pupil wider than right. Both react. Left lens clear, grey detachment of retina, disc visible. Tension − 1. Right eye emmetropic, with perfect acuity, and healthy in every respect.

October 5th, 1920: About six months after previous visit had scarlet fever, followed by measles. Left V. = barest P.L. Slight injection of ocular conjunctiva. Cornea bright. Good A.C. Iris lustreless. Pupil fairly round,

and of medium size. A few fine synechiæ posteriores. A small dilated vein on upper part of iris. A yellowish elevation at pupillary margin of iris below. Very numerous minute scintillating crystals lined the whole of the back of the cornea, the anterior surface of the iris, and the anterior surface of the capsule of the crystalline lens. No red reflection. Lens muddy and opaque.

November 17th, 1920: Condition absolutely altered. All the crystals have disappeared. The iris now *bombé* with radiating furrows on its surface, but the lens, as before, dull and opaque. Two brown dots have appeared at the posterior surface of the cornea below.

The only local treatment adopted during the whole of the period was instillations of drops of dionin gr. ij ad ℥j.

The crystals were most probably cholesterin. I have seen such in the lens, frequently in the vitreous, and rather rarely in the retina, but on no other occasion have I ever seen such a condition present in the anterior chamber.*

3. *Traumatic cataract from penetration of small foreign body.*

By J. Gray Clegg (Manchester).

Andrew P—, æt. 17 years. In September, 1919, patient was struck in his right eye by a fragment of steel. He had no knowledge of what had become of it. The next day he attended in the out-patient department and a diagnosis of abrasion of the cornea was made. There was some failure of vision noted some time after that accident, although he continued at work.

A second accident occurred on September 23rd, 1920, and on the following day I saw him myself. I then found a small scar in the centre of the cornea. A corresponding linear scar, 1 mm. long, on the anterior capsule of the lens, and a somewhat diffuse star-like opacity in the

* See also this volume, p. 139, line 2 (Ed.).

posterior cortex. The conclusion come to was that the damage to the eye resulted from the first accident. A radiogram was taken, but was negative, and there were no signs of siderosis. Evidently the house-surgeon, who first saw the case in 1919, overlooked the perforation, and this view is confirmed by the fact that the patient himself saw a foreign body, which came away before arriving at the hospital on the second occasion.

Unfortunately the left eye is amblyopic, although there is no history of previous squint, and fusion sense is present. No treatment has been adopted, awaiting possible further extension of the opacity. If so, it is proposed to bring the eye to the giant magnet, and remove any foreign body brought forward, dealing with the crystalline lens at the same time, or at a later sitting.

The case illustrates the necessity for a careful examination, even when an accident appears to be absolutely trivial, but here the proof of the penetration of the cornea and lens is purely from the clinical appearances.

Meeting held at Leeds, November 19th, 1920.

4. *The cribriform ligament of the ciliary muscle: A demonstration of the comparative anatomy of the angle of the anterior chamber in man and monkeys.*

By Thomson Henderson (Nottingham).

The essential features in the anatomy of the angle of the anterior chamber, which I herewith describe, are not merely of academic interest, but are factors of considerable physiological and pathological significance.

In the past we have been so dominated by the influence of the fetish of teutonic thoroughness in matters ophthalmological, as in the other domains of medical science, that the trade mark "Made in Germany" has ever been a sure passport for general recognition. For no other reason

could otherwise the term *Ligamentum pectinatum iridis*, introduced by Hueck, have been so universally adopted.

I have discussed in detail in previous communications (1), and particularly in my work on glaucoma (2), that the appearance which this structure presents, as arising from a splitting up of the periphery of Descemet's membrane and terminating by bending into the tissue of the iris root, is due entirely to oblique sectioning. A study and comparison of serial sections, in both the antero-posterior and transverse directions, show that in the human eye there is no such structure as the pectinate or comb-like ligament of the iris. I can now support this view by a further extensive research in monkeys' eyes, likewise carried out by serial sectioning.

The following is a list of the animals examined:

Old-World Monkeys:

Baboons.—Chacma, yellow, mandrill and ibean (Fig. 84).

Macaques.—Common macaque, bonnet and rhesus monkey (Fig. 85).

Mangabys.—Hagenbeck's and grey-cheeked mangaby (Fig. 86).

Guenons.—Sykes' and Jentinck's cercopitheque (Fig. 87). Tantalus, mona and patas monkey (Fig. 88).

Thumbless.—White-tailed guereza.

Langurs.—Entellus, proboscis and purple-faced monkey (Fig. 89).

New-World Monkeys:

Squirrels.—Squirrel monkey.

Capuchins.—Brown and white-fronted capuchin.

Spiders.—Red-faced spider monkey (Fig. 90).

Douracoulis.—Feline douracouli.

Before dealing with this material I will first describe briefly the angle of the anterior chamber, as I perceive it in the human eye by reconstruction from serial sections, and then emphasise my points by a comparison with the simian eye.

The Cribriform Ligament.

To appreciate the topography of the anterior chamber, it is essential at the outset to realise the fact that Descemet's membrane is a cuticular formation laid down and formed by the posterior corneal endothelium. Thus throughout the mammalia it progressively thickens with advancing age. In man (Fig. 83) Descemet's membrane (D.M.) ceases some little distance in front of Schlemm's canal (S.C.). Serial sections demonstrate and prove that the network on the inner side of that venous sinus is composed of a regular lattice-work of longitudinal and circular connective-tissue fibres, which are a direct continuation of the inner lamellæ of the cornea. Because of this regular net-like disposition of these fibres I have suggested the term "cribriform ligament."

Proceeding backward along the inner side of Schlemm's canal, the ligament terminates in two well-defined divisions—a small outer portion which blends with the sclera, and a considerably larger inner part that acts as the true ligament of origin for the longitudinal (1–3) and radiating fibres (4–8) of the ciliary muscle, at the same time operating as a check ligament to the circular (c).

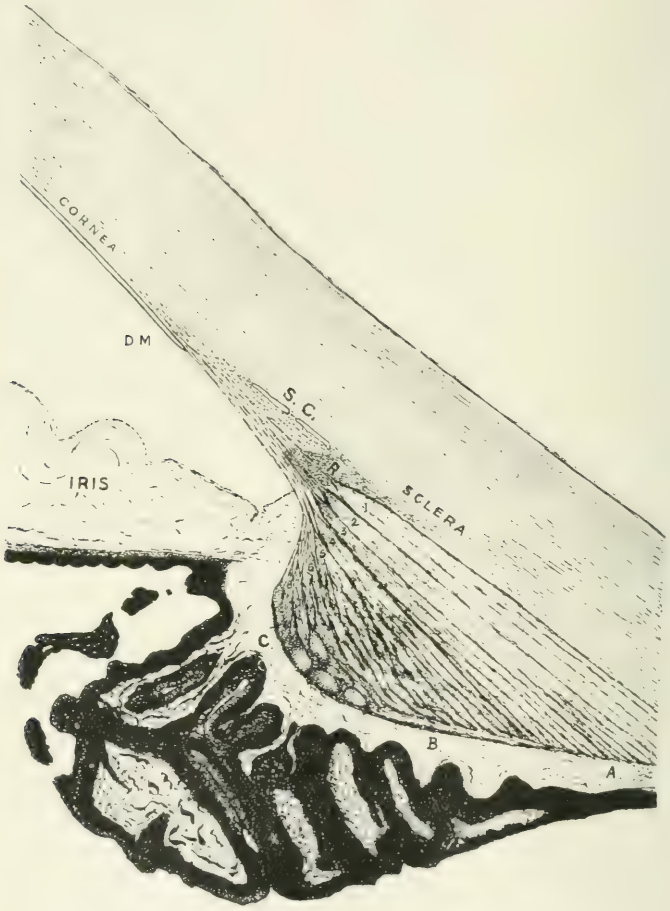
On a level with the hinder end of Schlemm's canal there is a special aggregation of the circular fibres of the cribriform ligament to form the scleral ring (R), which is traversed by those fibres that give attachment to the longitudinal muscle-bundles (1–3) of the ciliary muscle. The function of the scleral ring is obviously that of an anchor, keeping the ligament in position when the muscle is in action. It is only present in the human eye.

Comparative anatomy and the study of serial sections show a disposition of these structures that, I submit, negatives the views suggested by Prof. Arthur Thomson (31).

The angle of the anterior chamber is a true angle formed by the junction and attachment of the iris root to the cribriform ligament. The iris is merely adherent,

and no fibres of the one tissue pass or merge into the other. Hence the necessity of discarding the term

FIG. 83.



The cribriform ligament and angle of the anterior chamber in human eye.

"pectinate ligament of the iris" and substituting for it that of "cribriform ligament of the ciliary muscle."

This structure is a true net-like ligament arising from

the inner lamellæ of the cornea and terminating as the ligament of origin to the ciliary muscle.

In consequence the aqueous comes into direct contact not merely with the venous walls of Schlemm's canal, but it also passes forward between the corneal lamellæ to supply the cornea with the necessary pabulum. Posteriorly the aqueous passes between the heads of origin (1 to 8) of the ciliary muscle, and so diffuses out into the supra-choroidal space as well as into the loose stroma of the ciliary body generally. The percolation of aqueous into the ciliary tissue is no doubt assisted by the presence of "crypts" on the iris surface. A small crypt at the extreme base of the iris root is shown in the section.

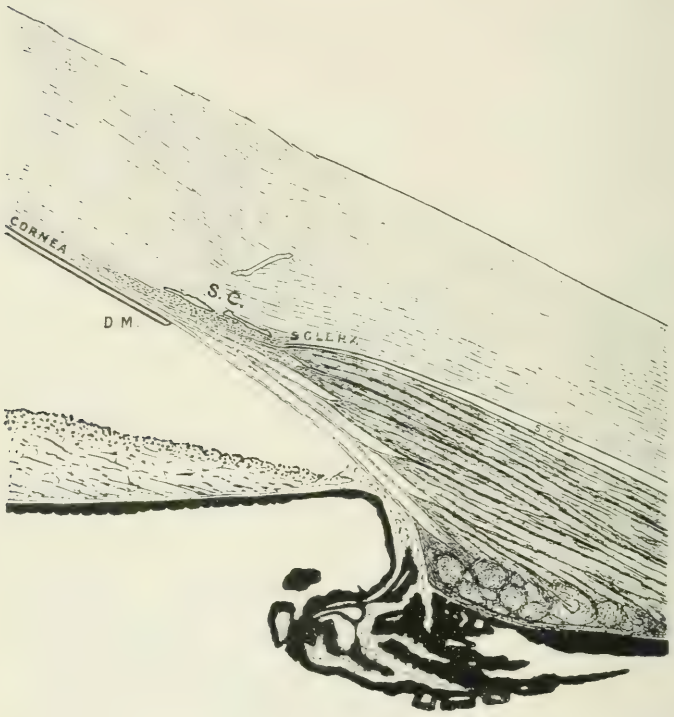
It has always been hypothecated that, in accommodation, the angle of the anterior chamber deepens to make room for the aqueous displaced by the increased convexity of the lens. No such anatomical deepening can, however, take place. In accommodation the circular fibres (c) of the ciliary muscle, by contracting inwards in a sphincter-like manner, will pull their check ligament taut, and the cribriform ligament is opened out thereby in a fan-shaped manner. The anatomical angle of the anterior chamber is actually moved inwards, but a physiological deepening takes place by the passage of fluid into the potential cavity of the supra-choroidal space. In monkeys the absence of the scleral ring makes this passage into the supra-choroidal space still more free and unimpeded.

The Ibean Baboon (Fig. 84).

Descemet's membrane (D.M.), instead of terminating, as in man, well in front of Schlemm's canal (S.C.), proceeds much further back and actually overlaps it. The origin of the cribriform ligament from the inner lamellæ of the cornea is thus more obvious. As in the human eye, the outer portion of the ligament is incorporated into the sclera, thereby preventing Schlemm's canal being influenced in the slightest by the action of the ciliary muscle attached to the inner portion. This arrangement

is common to both man and monkeys—I might even go further, and say throughout the Mammalia. When we consider the purpose of it one must admit that it is a very necessary disposition. The fact that the cribriform

Fig. 84.



Ibean baboon.

ligament acts as the ligament of origin to the longitudinal and radiating fibres of the ciliary muscle is very striking.

The iris is attached to the cribriform ligament at a point, in relation to Schlemm's canal, considerably further back than in man. Thus the anterior extremities of the ciliary muscle bundles project, so to speak, into aqueous, while the non-existence of a scleral ring facilitates the

passage of aqueous into the ciliary tissue and supra-choroidal space.

The section also brings out the relationship of the cribriform ligament to the circular fibres of the ciliary muscle, the sphincter contraction of which causes the ligament to spread inwards in a fan-like manner. Thus the angle of the anterior chamber is shifted in, but as the interstices of the cribriform ligament are still further opened, the effect is a physiological deepening of the angle by the ready transference of aqueous into the supra-choroidal space as distinguished from the anatomical deepening described in text-books.

The Rhesus Monkey (Fig. 85).

Descemet's membrane (D.M.) does not, unfortunately, stand out as clearly in the reproduction as in the original print. The microphotograph, however, demonstrates very clearly the corneal origin of the cribriform ligament as well as its termination. The inner lamellæ of the cornea actually overlap Schlemm's canal (S.C.) in the form of a spur (SPUR) from which the cribriform fibres radiate backwards, the outer portion passing into the sclera and the inner portion acting as ligament of origin to the ciliary muscle. Descemet's membrane proceeds as far back as the extremity of the corneal spur and then ceases.

In the process of mounting the ciliary process has become somewhat detached, making the supra-choroidal space (S.C.S.) appear as an actual instead of a mere potential space. This slight detachment, however, brings out the fact that some of the more superficial longitudinal fibres of the ciliary muscle are directly attached to the sclera. In the monkey this scleral attachment appears to be quite a common and normal condition, which would make up for the absence of the anchoring effect of the scleral ring of the human eye.

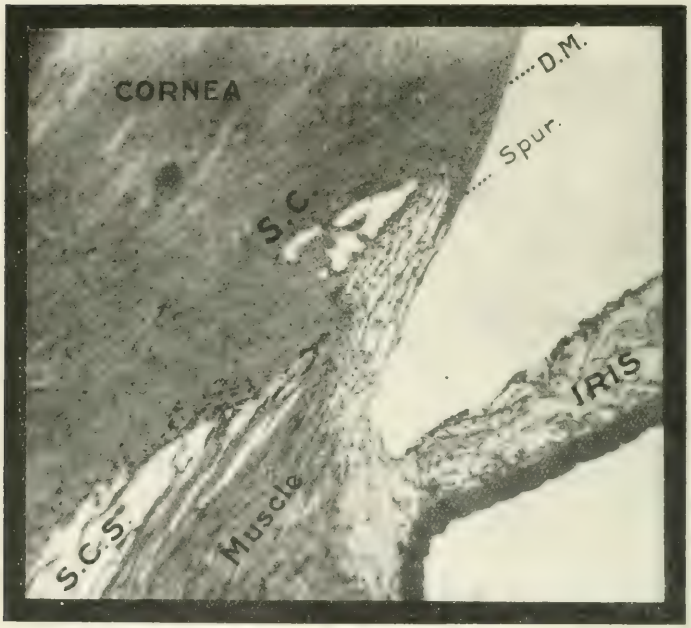
The section also illustrates the complete absence of any obstruction to the passage of aqueous into the supra-

choroidal space and tissues of the ciliary process generally.

The Grey-Cheeked Mangaby (Fig. 86).

The ciliary process is *in situ*, and hence the supra-

Fig. 85.



Rhesus monkey.

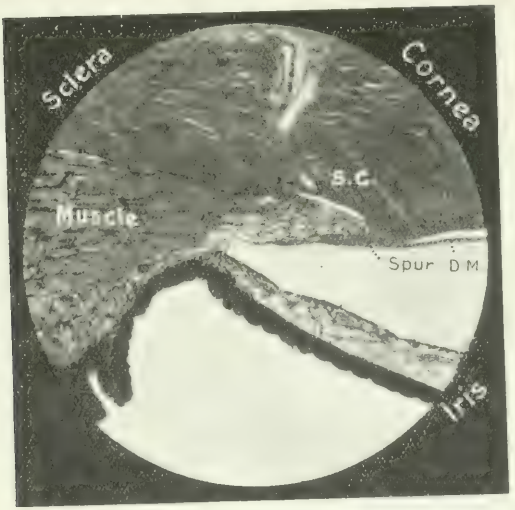
choroidal space, being a potential space, is not visible. There is here the same formation of a corneal spur as shown in the section of the rhesus monkey, only here it is even still more marked and overlaps Schlemm's canal to over half its extent. Descemet's membrane (D.M.), which in the process of mounting has become partially detached, terminates with the corneal spur. It takes no part in the formation of the cribriform ligament. The heads of origin

of the ciliary muscle lie obviously bathed in aqueous, and in consequence aqueous must percolate throughout the ciliary structures.

Jentinck's Cercopitheque (Fig. 87).

The corneal spur from which the cribriform ligament

Fig. 86.

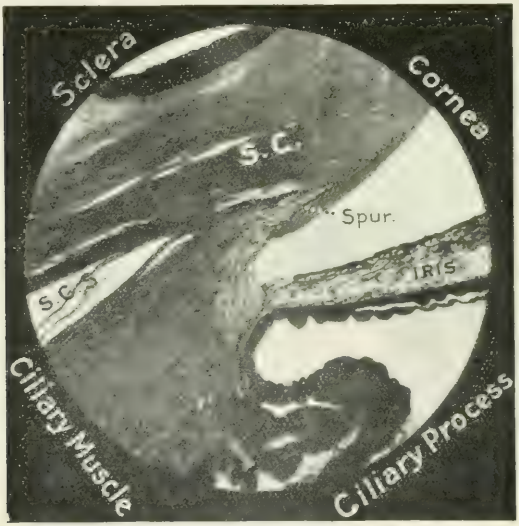


Grey-cheeked mangaby.

arises is here developed to the highest degree, for not only is it of considerable thickness, but it overlaps Schlemm's canal for at least three-quarters of its extent. The object of this corneal prolongation or spur is obviously to give greater strength and stability to the origin of the cribriform ligament without in any way interfering with the access of aqueous to Schlemm's canal. At the same time the microphotograph shows that there is nothing to prevent the aqueous from passing forwards between the corneal lamellæ forming the spur, and so into the corneal tissue generally, or from passing backwards between the

bundles of the ciliary muscle and reaching the supra-choroidal space on the one hand, and on the other percolating through the loose connective-tissue stroma of the ciliary body generally. In this specimen, as in Fig. 85, the ciliary process has become detached, and so it shows some longitudinal muscle-fibres obtaining a direct origin from the sclera.

Fig. 87.



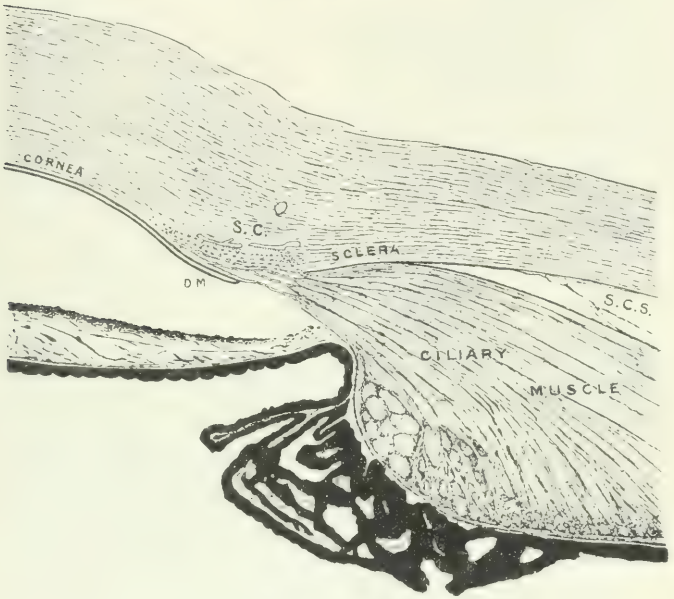
Jentinck's cercopitheque.

The Patas Monkey (Fig. 88).

This is a most interesting and instructive specimen, as it shows the ciliary muscle actually taking a part in the formation of the angle of the anterior chamber. Descemet's membrane (D.M.) and the adjacent corneal fibres overlap Schlemm's canal in the form of a small spur. The two divisions of the cribriform ligament are very clearly shown, the outer terminating in the sclera and the inner acting as tendon of origin for the ciliary muscle. The fasciculi of the muscle come well forward, so the length of the ligament is proportionately reduced. That the cribriform

ligament is the true tendon of origin of the ciliary muscle is obvious, as likewise is the fact that none of its fibres pass into the iris root. The iris does not even come into contact with the ligament, but is directly attached to the muscle. Note the crypts on the surface of the iris, at the extreme base of its root. The existence of a free

FIG. 88.



Patas monkey.

passage of aqueous from the angle of the anterior chamber into the ciliary tissues is self-evident. This passage takes place not only through the interspaces between the ciliary muscle, but it is assisted by the presence here of crypts on the iris root. The supra-choroidal space, owing to detachment of the ciliary body, appears as an actual space.

THE PURPLE-FACED MONKEY (Fig. 89).

This specimen presents still another variation in detail,

proving the origin and nature of the cribriform ligament.

Descemet's membrane (D.M.) stops short at a point just

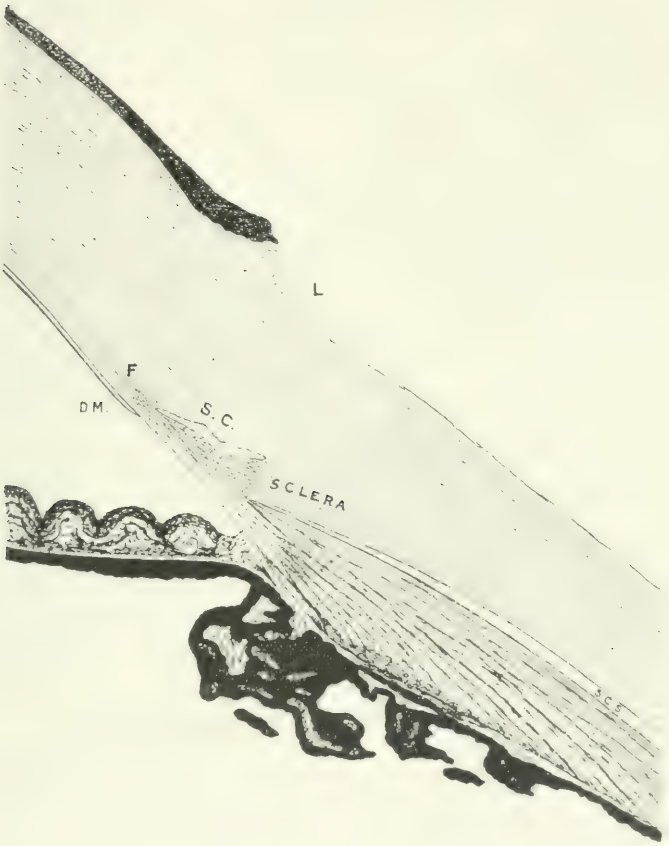
FIG. 89.

The purple-faced monkey.

anterior to Schlemm's canal (S.C.), while the innermost lamellæ of the cornea are united in a stout strand (C.L.), which gives a common attachment to the inner fasciculi (6, 7, 8) of the ciliary muscle. Such strands were scattered in an irregular fashion about the circumfererence of the anterior chamber. In the proboscis monkey, belonging

also to the same family of Langurs, exactly similar stout bands were met with, attaching the ciliary muscle to the cornea.

Fig. 90.



Red-faced spider-monkey (New World).

In the adjacent sections and other parts of the circumference of the angle of the anterior chamber the cribriform ligament was split up into the usual fine fibres, giving individual attachment to the muscle-bundles,

showing that these thickened bands are nothing more than a cohesion and synthesis of the finer strands of the ligament.

The cribriform ligament appears folded in consequence of the marked detachment of the ciliary body.

The other points of interest in this section are similar to those already detailed in the other specimens and therefore need not be further particularised.

The Red-Faced Spider Monkey (New World) (Fig. 90).

The angle of the anterior chamber in the new-world monkeys shows the same general features found and already enumerated in man and the old-world monkeys.

I, however, illustrate a section from the red-faced spider monkey, because in it I have been fortunate enough in striking a single fibre of the cribriform ligament (F.), which follows an uninterrupted course from the cornea to the outer fasciculus of the ciliary muscle.

This section emphasises the fact, already observed, how well protected Schlemm's canal is from compression when the ciliary muscle is thrown into action.

It also shows the absence of any barrier to the passage of aqueous forward into the cornea, or backward into the supra-choroidal space, and the structures composing the ciliary body.

Summary and Conclusions.

(1) In the *Primates* there is no such structure as the pectinate or comb-like ligament of the iris, described as arising from a splitting-up of Descemet's membrane and ending in the iris root.

(2) Descemet's membrane is a cuticular structure deposited by the posterior corneal endothelium. Hence it progressively thickens with age.

(3) Serial sections (antero-posterior and transverse) show that the inner lamellæ of the cornea are continued

backwards as a regular lattice-work of longitudinal and circular fibres forming a cribriform ligament.

(4) The cribriform ligament divides into two portions – an outer, which becomes incorporated with the sclera, and thereby prevents the venous sinus from being influenced in any way by the inner or tendinous portion proper, which acts as the true ligament of origin for the ciliary muscle and as a check ligament to its circular fibres.

(5) The scleral ring is a special aggregation of the circular connective-tissue fibres of the cribriform ligament. Its function is that of an anchor keeping the ligament in position when the ciliary muscle is in action. It is only found in man.

(6) The angle of the anterior chamber is a true angle formed by the junction and attachment of the iris root to the cribriform ligament. No fibres of the one tissue pass or merge into the other.

(7) The cribriform ligament allows not only free access of aqueous to Schlemm's canal, but at the same time there is no anatomical barrier preventing the aqueous from percolating anteriorly between the corneal lamellæ (so supplying them with fluid for their nourishment), or from passing posteriorly between the heads of origin of the ciliary muscle, and so infiltrating the ciliary muscles and entering into the supra-choroidal space.

(8) In accommodation the sphincter action of the circular muscle-fibres causes the ligament to open inwards in a fan-like manner. The angle of the anterior chamber is encroached upon, but the physiological effect is the same as the hypothetical anatomical deepening, because of the ready transference of aqueous into the supra-choroidal space.

(9) The absence of any water-tight compartments at the angle of the anterior chamber has an important bearing on the question of aqueous formation. One school of thought regards the aqueous as a filtrate. If this be the case, it is imperative that the essential factors for filtration be present, *i. e.* definite compartments in

which the hydrostatic level of pressure on one side of the filtering membrane is higher than on the other.

A survey of the specimens illustrated shows that no such definite compartments exist.

The aqueous passes freely between the heads of origin of the ciliary muscle, and therefore such fluid as exists in the loose areolar tissue of the ciliary body and processes must lie at the same level of pressure as the aqueous.

The filtering membrane is the double layer of cells clothing the ciliary processes, but the whole of the demonstration has gone to show that the same fluid is found on either side of this membrane.

If filtration were the sole factor in aqueous formation, one must visualise what this implies. Fluid must first filter through the walls of the ciliary capillaries, and then it has still to filter through the double layer of cells of the *pars ciliaris retinæ* to pass into the posterior aqueous chamber. To effect this latter, it is essential that the tissue of the ciliary process be enclosed in an otherwise water-tight compartment to compel the fluid to take the only one route available and filter through the ciliary epithelium into the posterior aqueous chamber. Existing anatomical conditions in both man and monkeys show that no such special water-tight compartment exists.

The cribriform ligament is not a water-tight structure, hence the ciliary tissues are infiltrated by aqueous from the angle of the anterior chamber. The result of this must be that any fluid filtered from capillaries would simply lie in the ciliary tissues, and could not be driven by hydrostatic pressure through the ciliary epithelium. In short the essential factor for filtration—a difference in hydrostatic level on either side of a passive filtering membrane—does not exist.

Structure and function must go hand in hand, and so, whatever may be said to the contrary, it is obvious, in the absence of anatomical conditions suitable for filtration, that the aqueous must be the product of cellular activity, otherwise a secretion.

Histological evidence supports in full, on the anatomical side, the work of Leonard Hill and Flack on the secretion of aqueous.(4)

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(1) Henderson, Thomson.—"The Anatomy of the So-called Ligamentum Pectinatum Iridis," *Trans. Ophth. Soc.*, vol. xxviii.

(2) Henderson, Thomson.—*Glaucoma: An Inquiry into the Physiology and Pathology of the Intra-ocular Pressure*, Arnold, London, 1910.

(3) Thomson, Arthur.—*The Ophthalmoscope*, vol. viii, 1910.

(4) Hill, Leonard, and Flack.—"The Secretion of the Aqueous and the Intra-ocular Pressure," *Proc. Roy. Soc.*, vol. lxxxv, b, 1912, also *Proc. Roy. Soc. Med.*, vol. v, 1912–13.

Meeting held at Bradford, December 8th, 1920.

5. *The nutritive supply of the macular region in the light of a case of embolism of the inferior temporal artery.*

By Percival J. Hay.

(With Plate XII.)

On February 26th, 1920, Miss F. A. R—, æt. 24 years, was sent to see me by Dr. Selby, of Tinsley.

Her history was as follows: During the morning of February 21st she had had an attack of dizziness and lay down to rest. On getting up again she noticed a cloudiness before the left eye, and she could not distinguish anything with it either straight in front, or to the right, or above.

Her previous health had been good until four years ago, when an attack of rheumatic fever confined her to

bed for several weeks. Since then her health had been pretty good.

The doctor informed me afterwards that the fever had left her with mitral incompetence.

On examination I found R.V. = $\frac{6}{5}$: media and fundus normal. L.V. = hand-movements ; media clear.

The retina of the left eye showed the usual appearances associated with obstruction of the arterial circulation. In this case the changes were confined to an area (see Pl. XII) bounded on the inner side by the inferior temporal vein, and above by an irregular wavy line which, extending outwards from the optic disc, skirted the macular region in semicircular fashion below and then passed on to the periphery of the fundus. The area so defined was an opaque white, unrelieved by any colour save a few fine red lines, representing the collapsed branches of the inferior temporal artery. There were no hæmorrhages.

On the disc, riding upon the fork formed by the division of the inferior retinal artery into the two main branches, a spindle-shaped, greyish-white swelling distended the lumen of the temporal branch and encroached slightly upon the nasal one. In diameter it measured about one and a half times that of the corresponding superior temporal artery. Below it, *i. e.* on the distal side, the temporal branch was narrowed down to a mere thread, while the other one was much reduced in size (not quite accurately shown in the drawing).

The subsequent course of the case was uneventful. The retina gradually resumed a normal colour. On March 18th—about a month after the onset of the symptoms—it was a pale pink with a shot silk appearance, except in a small quadrilateral space formed by a branch of the inferior temporal artery, and two small vessels running up, one on each side of the macula. Here the retina was still white.

On July 24th the colour was restored all over. The swelling at the site of obstruction was still about the same size. The artery itself, though very thin, had

PLATE XII.

Illustrates Mr. Percival J. Hay's paper on The Nutritive Supply of the Macular Region in the Light of a Case of Embolism of the Inferior Temporal Artery (p. 481).

A indicates the inferior temporal artery. B indicates the inferior nasal artery.

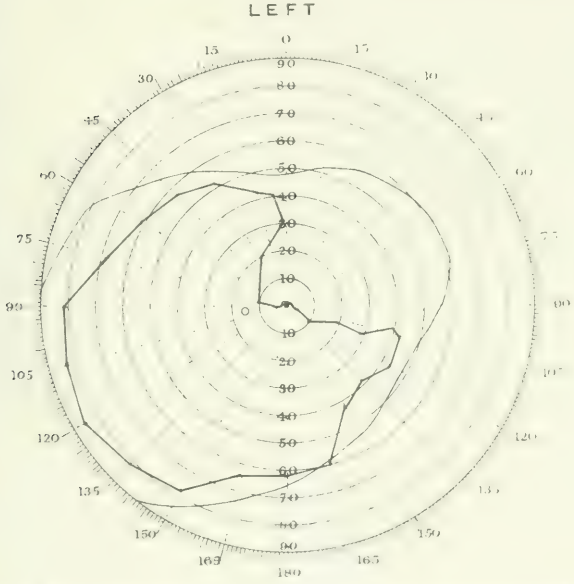
B A

Adlard & Son & West Newman, Ltd.

retained its colour. The uncorrected vision was $\frac{5}{7.5}$; with $-0{\cdot}75$ ax. hor. V. $= \frac{5}{6}$.

The field of vision (see Fig. 91) was contracted to within 0·5 or 1 degree of the fixation point in the meridians 0 to 90. The vertical line of demarcation seemed to follow the course and direction of the inferior nasal artery,

FIG. 91.



Miss F. A. R—, July 24th, 1920. Field for white: size of object 2 mm., distance 330 mm.

so that the injury to the retina had apparently extended further than was visible at the time with the ophthalmoscope.

It is unnecessary here to discourse upon the difficulties of differential diagnosis between embolism and thrombosis. These are well known. In the present instance, however, the diagnosis of embolism was probably as straightforward and as nearly justified as it ever could be without a pathological examination of the tissues.

Cases of embolism of a branch of the retinal artery are

rare. There are only two others in which this diagnosis appears in the literature of the last fifteen years. One is given by E. M. Alger,* and the other is described by Beatson Hird.† The former does not say anything about the cardiac condition of the patient. Whether it was a case of embolism is therefore open to doubt. Hird's patient was a man, æt. 31 years, who had valvular disease and a visible embolus of the superior retinal artery situated at the bifurcation into the temporal and nasal vessels. Normal vision of $\frac{6}{6}$ was recovered, and the appearance of the retina and vessels became normal, but the embolus was still visible nine months after the onset of symptoms. Hird's case is the only one I can find which is on all fours with my own

Apart from rarity, the case is of interest in another particular. It is stated in text-books that the nutrition of the macula is wholly dependent upon the choroidal plexus underneath. We read :

"The retinal arteries are to be regarded as terminal arteries. Consequently disturbance of circulation of the retina, arising from contraction or plugging of a vessel, cannot be compensated for by means of a collateral circulation. Within the retina the vessels lie only in the inner layers, so that the external layers of the retina are non-vascular, and are hence in part dependent for their nutrition upon the neighbouring chorio-capillaris. This is especially true of the fovea centralis, the central part of which contains no vessels at all."

Again, "There are no blood-vessels in the retina at the macula, so that its nourishment here is entirely dependent upon the choroid. By way of compensation the meshes of the capillary network of the chorio-capillaris are particularly dense here."

Clinically I believe there is nothing to substantiate this view, and Hird's case and my own appear to make it very clear that the vitality of the macula is above every-

* E. M. Alger, *Arch. of Ophth.*, 1909, p. 410.
† R. Beatson Hird, *The Ophthalmoscope*, 1912, p. 370.

thing dependent upon the retinal circulation. In embolism of the central artery the macula perishes. The network of choroidal vessels does not save it. On the other hand, if one of the temporal vessels only is obstructed, the other, by virtue of a free anastomosis of these two vessels at the macula (described by Nettleship and others), is able to maintain the vitality of the part, and although the vision is at first impaired, it is in the end more or less completely regained. And whereas the retinal arteries are terminal in other parts of the fundus, they are certainly not so at the macula, where, as these two cases show, a complete collateral circulation is provided. Much has been made of the fact that the macula itself contains no vessels. But neither does the cornea. And as in the case of the latter, it would appear that nutrition is provided by a circulation of lymph, supplied by the fine network of retinal vessels surrounding the macula. It need not be denied that the choroidal plexus lying underneath has any part whatever in the supply of lymph, but it is, perhaps, more nearly concerned in providing an extremely delicate mechanical support for the most highly organised part of the retina.

6. *Some remarks on the prophylactic treatment of myopia in school children.*

By J. A. Mortimer (Bradford).

In recent years much work has been done concerning the treatment of myopia from the prophylactic standpoint, and only feeble results have been attained. The enemy is the book. Masters and parents should know that near work cannot be unduly prolonged without danger, and should recognise that wisdom can be acquired otherwise than by studying books. Latin and Greek should be cut down, and open-air exercise encouraged. So states Ferlinck (1) in *La Clinique* for March, 1909.

In this vexed question I am enabled to place before

you certain results which my statistics seem to bear out concerning this prophylactic treatment of myopia in school children.

Before discussing the deductions from these statistics, it is perhaps well to explain the procedure adopted in the treatment of these cases. In Bradford all school children have their vision examined within the first year of entering school, and those whose vision is $\frac{6}{18}$ or less are sorted out and examined for the cause of this deficiency. It is from these children that are collected the cases of myopia. Those who have over 5 dioptres of myopia are recommended for instruction in a special school for myopes. This special school takes up to 65 children, where they are educated through the various grades till they leave at the age of 14 or 15. They have instruction according to the approved plans of good lighting, desks of suitable model to prevent faulty position and stooping, and equipped with small blackboards, on which they write with chalk. Blackboards are arranged at suitable height on the walls, and books of good clear type are in use. The teaching is as much as possible individual and oral, and no home-lessons are done. A great deal of attention is paid to the elements of the crafts which do not need book work, and which can be carried out without straining the eyes. Also an important consideration is that these children are striving both in work and play with neighbours who are their equals, both in learning and physique.

These myopes have their vision examined half-yearly by the medical officer and their particulars recorded on suitable case cards, and those whose condition has in any way changed are corrected. I see those children once a year and more frequently those whose condition demands it. The medical officer and the teachers advise the parents with regard to the general hygiene of home life and also with regard to over-use of the eyes in reading, sewing, etc.

This school has been established for about six years. At present the school is not in the most suitable environment, but much-needed plans are in contemplation for

transference to a more rural locality, where there will be the advantage of a more open-air school life with more opportunity for healthful exercise, and where part of the education will be conducted out of doors.

Formerly in about 20 per cent. of these cases there had not been full correction of the myopia or of the astigmatism, but latterly I have advocated that up to 10 D. the myopia and astigmatism should be fully corrected, and that over 10 D. the astigmatism should be fully corrected and the highest spherical given which is taken with comfort, also that the correction should be increased from time to time until nearly full correction be attained. The reason for this is, that in cases of high myopia the accommodation power is often deficient, and the full correction is not well tolerated in near vision.

In compiling these statistics I have calculated the average myopia, first on entering school, second on leaving school, and third after leaving school for about $2\frac{1}{2}$ years. The procedure adopted was to add together in each case the highest meridian of myopia in each eye, and to divide by 2, thus obtaining the average myopia in each child. I have here two groups of statistics, in which I thought it well to compare the respective results of treatment. The first, or A group, comprises those children attending the special school for myopes under the Education Committee, and the second, or B group, comprises those outside that authority, and whose myopia does not come under the same control.

In A group the average age at which they were first examined was 9·2 years, and the average age at which they entered the myope school was 9·5 years, and the average age at which they left school was 14.

In B group the average age at which examination first took place was 9 years, and the average age of leaving school was also 14.

So to all intents and purposes we have two groups which came under treatment for their myopia at approximately the same age.

A Group.

Average age.		During school life.			After leaving school.		
First seen.	Entering school.	Improved.	Stationary.	Worse.	Improved.	Stationary.	Worse.
9·2 years	9·5 years	55 per cent.	33·3 per cent.	11·6 per cent.	14·2 per cent.	64 per cent.	21·4 per cent.

Average Amount of Myopia.			Yearly Average Increase of Myopia.	
A. On entering school.	B. On leaving school.	C. After leaving school.	A. At school.	B. After leaving.
(1) Under 10 D., 5·1 D.	(1) 6·1 D.	(1) 6·8 D.	(1) ·25 D.	(2) ·3 D.
(2) Over 10 D., 10·7 D.	(2) 11·8 D.		(2) ·27 D.	

B Group.

Average age.		During school life.			After leaving school.		
First seen.	Entering school.	Improved.	Stationary.	Worse.	Improved.	Stationary.	Worse.
9 years	—	34·7 per cent.	56·5 per cent.	8·8 per cent.	15 per cent.	53·8 per cent.	31 per cent.

Average Amount of Myopia.			Yearly Average Increase of Myopia.	
A. On entering school.	B. On leaving school.	C. After leaving school.	A. At school.	B. After leaving.
(1) Under 10 D., 4·5 D.	(1) 7 D.	(1) 8·9 D.	(1) ·5 D.	·7 D.
(2) Over 10 D., 11·6 D.	(2) 15 D.		(2) ·68 D.	

In A Group, 27·5 per cent., the myopia remained stationary and in four cases it actually diminished.

In B Group in only two cases did it remain stationary, and in not one did it improve.

In 30 per cent. of the cases examined myopic changes were found, and in 70 per cent. the fundus was either normal or showed just faint thinning.

The average time at school for those remaining was 4 years, for those who had left 2·5 years.

These cases who had previously left were examined 2·6 years after leaving school.

Now, however, children are having special school treatment at an earlier age—between 6 and 7—and we are thus able to bring these under correcting influence at an earlier stage in the progress of their myopia.

I would ask you to compare these two groups of statistics, in which in A group we find that in those leaving school at the age of fourteen, and also in those at present remaining in school, (1) 55 per cent. had improved vision, some very markedly so; (2) in 33·3 per cent. the vision remained stationary; (3) that in 11·6 per cent. the vision had diminished; whilst in B group (1) 34·7 per cent. had improved vision, (2) 56·5 per cent. had remained stationary, (3) 8·8 per cent. became worse.

We also find in A group that the average amount of myopia on entering school under 10 D. was 5·1 D. and over 10 D. 10·7 D., while on leaving school the average amount of myopia was 6·1 D. and 11·8—an increase during their school life of 1 D. and 1·1 respectively.

This makes an average increase of myopia in those cases under 10 D. of 0·25 D. per annum, and in those over 10 D. of myopia of 0·27 D. per annum.

In B group of cases the average amount of myopia on first examination was 4·5 D. under 10 D. and 11·6 D. over 10 D., while on leaving school it was 7 D. and 15 D. respectively—an increase of 2·5 and 3·4 respectively. This makes an average increase per annum of myopia of 0·5 D. in those under 10 D. of myopia and 0·68 D. in those over 10 D.

I was able to trace a considerable number of cases in both groups who had left school and had been at work for two to three years. Here again we find in A group 64 per cent. remained stationary in vision, 14·2 per cent. continued to improve and 21·4 per cent. became worse, whereas in B group 53·8 per cent. remained stationary, 15 per cent. improved and 31·8 per cent. got worse. Also in A group there was an increase of 0·7 D. of myopia while B group showed 1·9 D. increase—a yearly increase of 0·3 D. and 0·7 D. respectively.

The average time these cases remained at school was four years.

In 27·5 per cent. of cases attending the special school the myopia remained stationary and in four cases it actually improved, while in B group only in two cases did it remain stationary and in none did it improve.

With regard to the effects of full and under-correction of the myopia present the ratio is as 1 to 1·8 increase, *i. e.* to say that the myopia tended to increase almost double in those cases which were under-corrected compared with those cases which were fully corrected. This is at variance with the view of Seggel (2), who asserts that the progress of myopia is practically the same for full and under-correction up to the age of sixteen.

In going through the notes of these statistics several points worth recording present themselves:

(1) The increase of myopia beyond the average yearly rate and the diminution of vision in those children who had some severe illness, *e. g.* pneumonia, or had indifferent health for a longer period or who were tubercle bacilli suspects. It thus seems to me that the refraction and vision vary with the state of general health. These cases, when they recovered their health, recovered also their vision, and the average increase of myopia approximated the usual average again.

(2) In no case did I come across detachment of the retina.

(3) That damaged eyes showed the progress of myopia more than eyes which were not damaged.

(4) In 30 per cent. of the cases examined myopic changes were found, varying from thinning of the posterior segment with crescents to well-marked posterior staphyloma and choroidal changes at the macula and elsewhere. In 70 per cent. the fundus was either normal or showed very slight thinning, but no crescents or choroidal changes. These fundal changes were in direct relationship to the amount of myopia, and appeared to me to be due to stretching and not to inflammatory changes.

5) I have noticed in the examination of secondary school children, that a fair number of cases which were either emmetropic or very slightly myopic showed at the age of 14–16 a change to myopia or an increase of myopia which seemed sudden, with diminution of vision, *e. g.* the following:

$$\left.\begin{matrix}\text{R.V. } \frac{6}{6}\\ \text{L.V. } \frac{6}{6}\end{matrix}\right\} \text{a year ago.} \quad \text{Now} \quad \left\{\begin{matrix}\text{R.V. } \frac{6}{18}.\\ \text{L.V. } \frac{6}{60}.\end{matrix}\right.$$

$$\text{R.K. } {}_{\cdot 5}: \text{ L.K. } {}_{1}. \quad \text{With correction} \quad \left\{\begin{matrix}\text{R.V. } \frac{6}{6}.\\ \text{L.V. } \frac{6}{9}.\end{matrix}\right.$$

This occurs at an age when these children are entering into the competition of life and finding their responsibilities. I merely mention this type of case for what it is worth, but at present have not sufficient statistics to enlarge on it.

I would submit in conclusion—

(1) That it seems that a total and frequent correction of the existing myopia is essential.

(2) That full correction has a decided and beneficial action on the progress of myopia and on the visual acuity.

(3) That prophylactic treatment at special schools has a markedly beneficial influence upon the progress and resultant vision in myopia, and that an essential point is to guard against over-use by a suitable programme both at school and at home.

(4) That such periodic supervision and special school treatment certainly give these children a better start off in life, and a better knowledge as to how to look after their vision and to choose their work and environment.

(5) That the general health of young children has, perhaps, the most important bearing on the progress of myopia.

I have not entered into the many theories of the causation of myopia, but I have laid before you the results of some statistics on a prophylaxis, which is the outcome of a blending of the best theories of recent years. I feel,

however, that these previously enumerated prophylactic measures, though of undoubted benefit, are merely accessory, and that what is more wanted is to get these children, and give them the advantage of a healthy condition of life in addition to these accessory measures at as early an age as possible. As has been aptly stated by Landolt (3), "Myopia also seems to me to be of constitutional origin, occurring in children who have not the constitutional health or that latent power of resistance necessary to neutralise the noxious influences to which their visual organs, as portions of a common whole, would be specially exposed."

References.

(1) Ferlinck.—*La Clinique*, March, 1909.

(2) Seggel.—"The Progress of Myopia," v. Graefe's *Archiv f. Ophthal.*, lvi, p. 3.

(3) Landolt, E.—*Royal London Ophthalmic Hospital Reports*, December, 1879.

Meeting held at Liverpool, February 11th, 1921.

7. *Discussion on the operative treatment of chronic simple glaucoma.*

Mr. Thos. H. Bickerton

opened the discussion, and showed a series of cases of chronic non-congestive glaucoma upon which he had performed Herbert's small-flap operation. He commented favourably upon the results.

Mr. Edgar Stevenson:

The time arrives in almost every case of chronic simple glaucoma when one is forced to contemplate operation, with a certain amount of misgiving as to the result—

whether it will turn out a permanent, or, as seems more frequently to happen, only a temporary success, or whether vision and field will still further be reduced and the operation from various causes be a failure.

Particular anxiety is caused in those cases where one eye is blind, and where, in the other eye, there is contraction of field in one sector up to the region of the macula.

Are we to hang on as long as possible with miotics, in the hope that the patient will get tired of us and go to someone else, or are we to risk obliterating the precarious central vision by an operation?

Having decided to operate, next comes the choice of operation. Those of us who have had a good many years of experience and therefore of many disappointments are naturally inclined to be conservative and to stick to operations of which we have done a good many. When I first started practice iridectomy and sclerotomy were really the only choice. This simplified matters for the surgeon, but was in results frequently disappointing to the patient.

So far as I can remember, I think that iridectomy was never done in these cases until treatment by miotics was proving unsuccessful, so that it is not altogether surprising that the operation should have proved a failure owing to the changes produced by long continuance of the disease. No doubt iridectomy or sclerotomy performed at the beginning of the disease, as in acute glaucoma, would stand a better chance, but I am sure that the newer operations give a better filtering scar.

I am much interested to see that several well-known surgeons, disappointed with their results in the newer operations, are going back to iridectomy and sclerotomy—in my opinion a retrograde step.

From 1867, when de Wecker published his discovery that the filtering cicatrix was the true object of the glaucoma operation, till 1906, when Lagrange introduced his sclerotomy operation, there does not appear to have

been any real advance in any operative procedure, but the last fifteen years have been full of interest to us, and have resulted in a new impetus and renewed enthusiasm being given to this most important problem.

There have been a number of modifications of the original Lagrange operation, amongst them Herbert's wedge operation, of which one hears very good reports, but of it and of his small-flap operation I have too little experience of my own to make any criticism of mine of any value, but Col. Herbert tells me that the most suitable cases for the small-flap operation are the early ones, easily controlled by miotics—just those cases where the patient is doing well under drops, feels quite comfortable, and is difficult to persuade that an operation should be performed.

About 1908 or 1909 Col. Elliot introduced sclerocorneal trephining, and I think it is very little exaggeration to say that many of us thought that as regards operation for glaucoma the millennium had arrived, but as our experience of the operation grew with its applications to all classes of cases, so also we began to have disappointments, and one began to hear of catastrophes, more particularly of late infection.

Nevertheless, in my opinion the successes far outweigh the failures, and I myself do not intend to abandon the operation, though I am quite prepared to try any other operation that appeals to me as a good one, such as Herbert's flap operation.

With regard to the failures of trephining, Col. Elliot has answered all criticisms in the most convincing manner in his book. For my part, I feel very strongly that most of the failures I have had were due either to some fault of my own, or to some unfortunate accident, such as coughing or sneezing, on the part of the patient, rather than to any fault of the operation as such, and perhaps some of the patients should not have been operated on.

I think the risk of late infection, if the operation is properly performed, is very much exaggerated. For the

rest I think that anything smaller than the 2 mm. trephine is useless—the smaller trephine openings will cease to filter properly after a few weeks or months.

Life nowadays is too short for the gathering of statistics, so that I can only give a sort of general idea of my trephine operations. I began to do it in 1911 and have had many of the curious and disappointing results that we have all encountered, but I judge that about 30 per cent. may be counted as real successes. By this I mean permanent reduction of tension, with arrest of the disease and some improvement in vision as observed for at least two years. About 50 per cent. are partial successes or partial failures, depending upon how one looks at them. By these I mean cases where it is necessary to keep up massage and treatment by drops in order to maintain reduction in tension. This leaves about 20 per cent. of definite failures from a variety of causes, such as failure of the anterior chamber to re-form, blocking of the trephine hole with uvea, retinal hæmorrhages, etc. I have never had a case of late infection, *i. e.* a septic iritis coming on twelve months or more after the operation, but I have had a case of septic iritis occurring a week after trephining, in which the eye was lost. I am quite sure this was due to sepsis introduced at the time of operation—luckily it was a blind eye—and possibly an eye that has been glaucomatous for many years is less resistant than usual to infection.

I have had one case which one might have expected to go septic, but did not do so—that of an old lady with very thin tissues, in whom I rather unwisely stitched the flap into position. She had a violent sneezing fit the day following the operation and the flap tore away from the limbus, leaving the trephine hole uncovered. It gave me a good deal of anxiety, and though I thought of trying to cover the wound with conjunctiva I finally decided to leave it. She did well for about three months, and then, after some unusual exertion, got detachment of the retina. The trephine hole is still open after six years, a small amount

of uvea is projecting, but the eye has never shown the slightest sign of irritation.

The only new operation I have seen is aqueoplasty, as practised by Mr. Zorab of Southampton. It seems to be an easy and safe proceeding in his hands, and I was much struck with some of the cases he showed at the last Congress. I have always intended to try it, but somehow I cannot quite get over my objection to leaving a foreign body in the anterior chamber.

A speaker at the Congress last May made some remarks that seemed to be of some importance—that in his opinion we were treating glaucoma too much from the surgical point of view, and that we should seek the assistance of the physician and bio-chemist, and arising from this there are one or two general observations I should like to make: first, as to the presence of a coincident disease or condition of health in the patient which may be affecting the optic nerve, already weakened by glaucoma.

The patient I showed this afternoon is a case in point. Her optic nerves were a good colour when I operated, but they passed into extreme atrophy in a few weeks during the attack of choroido-retinitis, although the ocular tension was much reduced in each eye. She has a positive Wassermann reaction.

Another patient with minus tension after operation and a healthy fundus has also gone on with rapidly-increasing atrophy of the nerve, and corresponding failure of the field and of central vision. It never occurred to me till reading of a similar case of Col. Elliot's that her teeth might be responsible.

She has had her teeth removed. I saw her the other day, and I believe the downward process has been checked. Many of you, perhaps, are accustomed to take these factors into consideration, but they are apt to be forgotten and I wish to emphasise them.

The use of the Schiötz tonometer.—I must plead guilty here to laziness or indifference, in that I never seem to have time to make a routine examination by

tonometer of my glaucoma cases; but it is only in that way that we can get an exact estimate of pathological tension. To give you an instance of what I mean, a patient of mine after trephining had apparently normal tension to palpation with the fingers, but his optic nerve, field and vision steadily deteriorated. I sent him to Col. Herbert, who found that the eye with apparently normal tension had 26 Schiötz, which seemed pretty good, but eserine brought it down to 19, thus showing that his normal tension must be lower than usual. He suggests a flap operation on this eye.

In conclusion, as far as my own work is concerned, the cases which give me the greatest anxiety are the very advanced ones. I have had two quite recently, no previous treatment, one eye of each quite blind, without any excessive tension of the other eyes, one with an almost hemiopic field, the other with a nearly complete paracentral scotoma. I have tried to imagine myself in the position of these patients, and what advice I should give myself, whether to submit to operation, and if so, what operation, or whether to sit down while using drops and await the inevitable, occupying myself by training a dog.

But I think we must all agree that risk is better than certain failure, therefore, can we do anything to diminish the risks, more particularly the hæmorrhages in the retina which so often follow a decompression operation?

Mr. J. Gray Clegg (Manchester):

Mr. Bickerton has referred to Mr. David Little's results from iridectomy. I have never seen a finer operator than Mr. Little. He made a very large incision and took away about one-third of the iris. I had a good deal to do with the preparation of Mr. Little's presidential address on glaucoma, in which he claimed 62 per cent. of successes. After an analysis of 247 cases of trephining of my own I found they showed 18 per cent. better results, viz. 80 per cent. as against 62 per cent. I have seen one or

two cases of panophthalmitis after a considerable interval. I have never had a case of immediate sepsis. One often gets a low type of iritis unless atropine is used *at the time of operation*. We, in Manchester, now invariably use atropine (full strength, gr. iv to ℥j) at the time of operation. I have done at least 500 cases. Because one gets one or two bad cases, it does not mean that one should give up an operation if it gives on the whole a larger percentage of successes. The cases (operated on by Herbert's method) that Mr. Bickerton has shown us are marvellously beautiful; apparently nothing better could be desired. I use a 2 mm. trephine and cut off the anterior two-thirds of the disc, so as to leave a slight hinge above. Years ago Mr. Hill Griffith described an operation, making a trephine hole without any conjunctival flap to cover it at all. These cases did all right: a fine membrane formed over the hole. One cannot be certain that any particular tension is *normal for the eye one is dealing with*. The tonometer is a considerable help. Other methods have to be employed. The scotometer is a most valuable means of ascertaining whether a case is progressive or not. In every case of doubt map out the blind spot and other scotomata in the central field. These give a much better and more accurate method of estimating the progress of the disease than the perimeter.

Mr. Hugh E. Jones:

I think in these cases of simple chronic glaucoma it is better to operate before the glaucoma begins—that is to say, where only the prodromal symptoms are present. A simple, moderate iridectomy should be sufficient in such cases. One advantage of Elliot's operation is that it can be repeated if necessary; I have done it three times in one case. At one time sclerotomy was the only operation done at Liverpool, at one of our hospitals, for chronic glaucoma. Recently I have used a 1½ mm. trephine, especially in early cases. The drainage obtained is as

good, and the chances of infection are less than with a larger opening.

Mr. Thomas Stevenson

pointed out that the Herbert operation left very little mark on the eye, and could be repeated if necessary. He had performed this operation in numerous cases.

Mr. Bywater

mentioned a case in which he had done sclerotomy as a temporary measure, but the result was so good that no further operation was called for.

Mr. T. D. Mackay:

A good deal of good was done by iridectomies before more recent operations were introduced. Of the newer operations I have only experience of the Elliot method, and I am quite content with the results I have had. Certainly, so far as my experience goes, I favour the Elliot operation.

Meeting held at Sheffield, April 29th, 1921.

8. *Discussion on the ocular symptoms of encephalitis lethargica.*

Prof. Arthur J. Hall:

It will be remembered that in the early spring of 1918 a series of cases were observed in this country presenting a symptom-complex of a kind with which we were not familiar, either from personal experience or from current text-book records.

It is true that von Economo had recorded a series of cases of a similar kind which he had observed in Vienna in 1916–17. Owing, however, to war conditions at that time, and the consequent difficulty of obtaining the current

medical literature of enemy countries, this observation of von Economo was not so generally known in this country at the time as it probably would have been under normal conditions, and it was not until after the early cases had been recorded that Economo's paper became generally known.

The outbreak began almost simultaneously in several centres. Sheffield was one of these, and although the actual number of cases recognised here as such did not total twenty, yet they were so remarkable as to arrest attention. Thus, for instance, during one week in March, 1918, I saw three cases of bilateral facial paralysis of spontaneous origin. Up to that time I had not personally seen a single case of facial diplegia in my thirty years' experience, and only about forty such cases could be found recorded in medical literature. It was therefore obvious that we were in the presence of something very unusual.

It is not necessary to elaborate what is by now well known to all, namely, that since 1918 this curious affection has been observed almost all over the world, and that so far from disappearing it is still occurring in considerable numbers. Von Economo called it "encephalitis lethargica," and that name has been more or less generally adopted, or, as an alternative, epidemic encephalitis. The lay press have called it "sleeping sickness," unaware that in using that name they were trespassing on ground already appropriated. Now they have modified it to "sleepy sickness," and so it stands with them at the present.

The question has naturally arisen, "Is this a new disease or is it a modification of some recognised infectious condition?" It is difficult to suppose that in the twentieth century some entirely new organism can affect mankind after having remained harmless for all these centuries. Moreover, there are records of epidemics in which lethargy and other symptoms have been prominent features, so that it is quite probable that this is not a "new disease" which has never occurred before. However that may be,

we may fairly say that it is "new to this generation," and that we have no clear record of such a wide-spread epidemic of this character occurring before.

It has been suggested that it is merely a novel form of some familiar disease. Two diseases have been named in this connection, epidemic influenza and acute poliomyelitis (Heine-Medin's disease).

It is not necessary or desirable that I should occupy your time in discussing all the "pros" and "cons" on this subject. As regards influenza, the differences are so wide that it is difficult to think they can have the same origin. It is said that such a lethargic disease has followed previous epidemics of influenza. Possibly, as has been suggested, there is some association between the two. As regards the relationship of lethargic encephalitis to acute poliomyelitis, if they are one and the same disease, the clinical differences which have spontaneously and suddenly arisen in acute poliomyelitis almost all over the globe seem more difficult to explain than if we assume they are distinct diseases.

Let us now turn to that aspect of this disease which must chiefly interest ophthalmologists, namely, the associated eye troubles.

Probably no organ has been more generally involved in the various types of this disease than the eye.

Some form of involvement of the eye muscles has been from the first a striking feature of the disease. In many mild or ambulatory cases visual troubles have been practically the only evidence of anything wrong, and many patients have, in the first instance, consulted an ophthalmic surgeon only. Even when other symptoms are marked it is often the ocular disturbance which causes the most distress. Only a few weeks ago a typical case of this disease was sent to me by one of your members, Mr. Caiger, whom the patient had consulted for his visual troubles. This limitation of the attack to a cranial nerve paresis throughout does not apply only to the eye muscles. One of my first series of cases published in the *Lancet*,

April, 1918 (Case 3), had as her only evidence throughout a bilateral facial palsy. It is therefore important that ophthalmologists should be familiar with the varied symptoms of the disease so that they may recognise cases; and further, it is often necessary for the general physician to ask the help of the ophthalmologist in dealing with the more obstinate eye complications which arise in the disease.

The eye troubles may be considered under four headings:

(1) Affections of conjunctiva, etc.
(2) Affections of extrinsic motility.
(3) Affections of intrinsic motility.
(4) Affections of visual fields and fundi.

(1) Conjunctivitis.

This is not uncommon in the early stages. There may be a suffusion of the conjunctivæ of transient duration, or in some cases of greater severity. As a rule it is not sufficient to call for treatment.

MacNalty* says: "This initial conjunctivitis is so common that it deserves special notice." In one of my cases, which proved fatal, the conjunctivitis was more marked and persistent than usual, and was associated with an early double parotitis, so that the case was at first suspected of being mumps. In cases where there is definite facial palsy, either uni- or bilateral, there is necessarily inability to close the lids. This, if persistent, may lead to secondary inflammatory trouble as in ordinary cases of facial palsy. In the first series of cases which I recorded in the *Lancet* in April, 1918, one woman (Case No. 3) had as her only symptom of the disease complete facial diplegia, and as a result had for some time afterwards rather severe conjunctival inflammation.

(2) Affections of Extrinsic Motility.

(*a*) *Ptosis.*—As a rule this is bilateral, and is rather a drooping of the eyelids with inability to open them com-

* MacNalty, A. S., *L.G.B. Report*, new series, No. 121.

pletely than a paralysis. It is a part of the whole picture of the lethargic, drowsy state rather than a uni- or bilateral ptosis of the ordinary kind.

When asked to open the eyes the upward movements of the lids are very slow, and it seems as if the act were a great effort—in fact it suggests the description of "eyelids heavy with slumber." When the lethargy is very great it may be impossible for the patient to keep the lids open for more than a very short time. This relationship between the ocular symptoms of encephalitis lethargica and the conditions in ordinary physiological sleep has been emphasised by Morax and Bollack† both as regards ptosis and loss of accommodation. Besides this sleepy form of ptosis, there is in a certain number of cases an ordinary ptosis, usually unilateral, and persisting for a longer or shorter time. In one of my cases it remained for some weeks after all the other symptoms had disappeared, eventually clearing up.

(*b*) *Strabismus.*—This is a fairly common and usually an early symptom. In most cases it is transitory, somewhat ill-defined, and variable. One day it seems to be in one position, another day elsewhere. Further reference will be made to this in discussing diplopia. In one of my cases an entirely new strabismus suddenly occurred many days after the patient had become convalescent. It disappeared later on.

One may here recall the now well-recognised fact that in this syndrome the poison, whatever it may be, seems to remain active in the system for quite long periods. This is shown particularly by the variability from day to day of the cranial nerve palsies.

I have referred to this variability in the strabismus, but the same applies to other cranial nerves. Thus when the disease has been in progress some days or even a few weeks there may be a temporary dysphagia, or the hitherto healthy side of the face may become completely

† Morax and Bollack, *Bull. et mém. Soc. Méd. des Hôp. de Paris*, 1920, 3me série, p. 199.

paralysed. In this respect it shows a marked difference to typical cases of acute poliomyelitis, in which the worst of the damage is usually at the first onset—any later change is usually in the direction of improvement.

(*c*) *Ocular movements.*—In a considerable number of cases the eye movements are abnormal. In many it is difficult to estimate accurately what particular muscles are involved: there is a general limitation of movement beyond a short distance, which may be most marked in some particular direction or in more than one direction. The condition in many cases recalls that seen in myasthenia gravis, in which the muscular weakness varies from time to time, as any group of eye muscles becomes tired. Morax and Bollack (*loc. cit.*) found a paresis of associated movements in six out of seven cases; in three it was when looking vertically upwards, in two downwards, and in one in both directions.

(*d*) *Nystagmus.*—In connection with the above the very frequent occurrence of a kind of nystagmus in this disease must be considered.

It formed a very striking feature in the symptom-complex of the early cases. I said "a kind of nystagmus," for it differs in certain particulars from the nystagmus seen in cerebellar tumour, in miners, or in ocular disease. It has been called "nystagmoid," or "nystagmiform" oscillations. It is usually brought into evidence when the eyes are moved, and varies according to the weakness of particular muscles. Sometimes in the early stages it is of extreme rapidity and irregularity, the eyes seeming to move asynchronously and in a quite disorderly manner. In one case recently seen it was associated with spasmodic twitching of the upper lids. It usually passes off with the other symptoms, but traces of it may persist for many months.

(*e*) *Movements of convergence* may be absent.

(*f*) *Diplopia.*—This is often the earliest symptom to make the patient seek medical help. Hence the ambulatory type of case often comes first to the ophthalmic

surgeon. The forms which it takes are, as may be expected from the preceding statements, very varied. In one case a patient told me that as she walked along the street the houses seemed to have an extra storey. MacNalty* records a patient who "declared that the people in the ward 'looked to her' as if they were walking on the top of one another." As a rule the diplopia disappears fairly early, unless there is any definite strabismus.

There is, I think, no doubt that in the early days, before the disease was so widely known, the true nature of a good many of these ambulatory cases with nothing but slight eye disturbances passed unrecognised.

(3) Affections of Intrinsic Motility.

(*a*) *Size and position of pupils.*—Wilson† says the pupils may be contracted, or dilated and fixed, or normal. He has observed well-marked ectopia pupillæ similar to what he has described in other mesencephalic lesions.

(*b*) *Inequality of pupils.*—This is not uncommon, the difference between the two sides being quite marked. It is usually of short duration.

(*c*) *Reaction to light* is usually normal.

(*d*) *Accommodation* is frequently defective. This may persist for a considerable time. Morax and Bollack (*loc. cit.*) refer to the similarity of loss of accommodation with normal light reaction to the condition found after diphtheria, but they point out that whilst in the latter this does not usually last for more than four to six weeks, in cases of encephalitis lethargica it may persist very much longer.

(4) Affections of Visual Fields and Fundi.

In most cases examined from this point of view the records state that no change was found either in the visual fields or in the fundi oculorum.

* *L.G.B. Report*, New Series, No. 121, p. 18.
† Wilson, S. A. K., *Lancet*, 1918, vol. ii, p. 17.

Exceptions, however, must be made to this statement. In a considerable number of cases there is no record of either having been investigated. It must also be remembered that hemiplegic cases may occur, in which hemianopia may occur. Buzzard* recorded three cases in which this was present. In two of these there were also definite changes in the discs, "swelling," "blurring of edges" and "engorged veins" being mentioned.

Alexander† in his five recorded cases had a somewhat exceptional experience, fundus changes being more or less present in all of them, "engorgement of retinal veins," "defective vision in left eye with slight choked left disc," "fulness of retinal veins and semi-obscuring of optic disc margins," "fulness of retinal veins," "marked fulness of retinal veins and obscuring of margin of optic discs" being recorded.

Bramwell‡ says that changes in the fundus oculi are seldom met with, although in several cases he has seen engorgement of the veins, and in two cases in which the diagnosis was not absolutely certain an optic neuritis was present.

Symonds§ reports four cases seen in America in which optic neuritis was associated with signs of wide-spread lesions of the nervous system consistent with the diagnosis of encephalitis lethargica used in its widest sense.

Personally I have not met with a definite optic neuritis in any of the cases I have seen. One case in which the symptoms simulated encephalitis lethargica very closely and the diagnosis of which was for some time in doubt developed a well-marked double choked disc, and at autopsy was found to have a cerebral tumour in the frontal lobes.

I shall not touch upon the many other aspects of this protean affection. To those who read any general medical

* Buzzard, E. F., *Lancet*, 1918, vol. ii, p. 835.

† Alexander, J. B., *Brit. Med. Journ.*, 1919, vol. i, p. 794.

‡ Bramwell, E., *Lancet*, 1920, vol. i, p. 1153.

§ Symonds, C. P., *ibid.*, 1920, vol. ii, p. 1245.

journal, it is almost impossible to escape reading about them.

Recent experimental work gives promise of further knowledge in the near future. At present there is no obvious line of specific treatment for this affection, which, in addition to causing temporary disablement, may lead to prolonged or even permanent damage of a serious kind, and not infrequently causes death.

Mr. Gray Clegg

said that he had seen at least a dozen cases of ophthalmoplegia in encephalitis lethargica. The commonest eye condition was one of paralysis, or paresis of one or more of the extrinsic ocular muscles, and in only two cases had he come across papillœdema.

In one moribund woman there were no intra-ocular lesions. It was not wise to accept the diagnosis of encephalitis lethargica too readily, for certainly not infrequently that label had been attached to cases which, in the post-mortem room, revealed tubercular or other forms of meningitis.

In quite a fair proportion of the cases the distressing diplopia, which was one of the first signs frequently noted, disappeared, but sometimes a permanent paralysis was left.

Mr. T. Milnes Bride:

I have seen four definite cases of encephalitis lethargica:

Case 1.—E. M—, female, æt. 22 years. Illness commenced in December, 1920. Examined several times and nothing abnormal detected in the fundi, ocular or lid muscles. She recovered but is now in a demented condition.

Case 2.—M. H—, female, æt. 28 years. Illness commenced in December, 1920. I could never find any abnormality in the eyes or muscular system, though early in the disease I thought the retinal vessels might be a little full. She made a good recovery and is able to read easily without glasses.

Case 3.—A. W—, female, æt. 14 years. Illness commenced early in December, 1920. On admission to hospital fourteen days later there was an internal strabismus of one eye due to paralysis of the external rectus muscle. She made a perfect recovery and the paralysis soon passed off. The fundi were quite normal.

Case 4.—F. S—, male, æt. 10 years. The first sign of illness here was a paralysis of the left external rectus muscle, for which his parents brought him to the Manchester Royal Eye Hospital. He was sent to a children's hospital and six days later the paralysis had gone. He made a good recovery and had no more ocular symptoms; fundi normal.

In these four cases the two adults had no ocular symptoms; the two children both had external rectus paralysis, which completely recovered; in one case it was the first sign that the child was unwell.

I record these cases as they may be useful for statistical purposes.

Mr. Herbert Caiger

referred to the single case of this kind which he had seen, and which he had transferred to Dr. Hall. In this case death occurred on the twentieth day of the disease. Such a speedy fatal ending had surprised him, as the impression gained from the published literature of the disease was not that the disease was often so acute or so severe. The history of the case was as follows: W. H. B—, a robust man, æt. 36 years, working as a colliery deputy, seen first on December 4th, 1920, with history of "mist in front of the eyes," noticed first three days before, on waking in the morning. There had been diplopia on the same day which had since passed off. Testing with Maddox rod there was 18 of esophoria. For distance R. V. $\frac{6}{6}$, L.V. $\frac{6}{6}$; slight ptosis. Heavy apathetic manner, supposed at the time to be usual and normal with this patient; no definite diagnosis made. He became worse so quickly during the next week that he came for

re-examination on December 11th, 1920, only a week after his first visit; he was then obviously ill; loss of appetite, peculiar gait, sleepy appearance and manner, and a dusky "waxy" look of face and lips were noted. He was sent to Dr. Hall as being possibly a case of encephalitis lethargica. Dr. Hall reported that the case was a typical one of the ambulatory type; he noted slight nystagmus. He was admitted to the Royal Hospital, Sheffield, on December 13th. By that time there was urinary incontinence. No voluntary movements except respiratory. Attempts to raise right upper eyelid were resisted; left upper lid could be raised easily; paresis of left side of face, increasing later. Temperature for first four days after admission was 99° to 101° F., rising higher in the next three days (101 to 103·4°). On December 20th, the day of his death, the temperature rose steadily from 103·4° at 2 a.m. to 105·8° at 6 p.m., four hours before death. Transient twitchings of the left arm and leg, of face, and later of both legs, were noted during the last week. On December 18th the fundi were examined by Mr. Percival Hay, who reported: "Greyish pallor extending over whole retinæ of both eyes. Retinal arteries very thin. No neuritis. No hæmorrhages." At the post-mortem examination nothing of significance was found macroscopically.

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9. *Note on a visit to Barcelona to see Prof. Barraquer's operation of phakoërisis (extraction of cataract by suction).*

By F. P. Maynard.

Since Macnamara in India, Wright in America and Pagenstecher in Wiesbaden removed cataracts in their capsules over forty years ago we have all realised that that is the ideal to be aimed at.

Smith's operation of expression—squeezing out the lens by pressure—has gained many adherents, but it has many

dangers, and on account of these I gave it up years ago after thorough trial.

Prof. Barraquer, of Barcelona, has for several years been working at an operation that aims at drawing the lens in its capsule out of the eye by suction. The principle is, of course, the exact opposite of that employed by Smith in his expression.

Barraquer calls this operation "phakoérisis"—literally a drawing-out of the lens. The accounts given of it and the excellence of the published results, combined with my own conviction that drawing out must be better than squeezing out a lens, led me to pay a visit last Easter to Barcelona in order to see Dr. Barraquer and his work at the University Clinic. Dr. Barraquer has a charming personality and is modest and sincere. He made me welcome and showed me everything possible in the few days I was able to stay.

The best plan will be to give a short account (1) of his instruments, (2) of the operation, and (3) of his results.

(1) *Instruments.*—I may say that Dr. Barraquer is a mechanical genius. In the very early days of automobiles he designed and made himself a complete, large working model of one. The idea of suction was originally suggested to him by the tentacula of polypi, the toes of climbing frogs and by leeches, all of which grasp objects strongly and without violence. He first used a cannula with an aspirator and buccal suction. The vacuum was weak, but he once succeeded in extracting with it. The degree of vacuum necessary he finally found to be equal to that produced by a column of mercury 40 to 60 mm. in height.

With an ordinary simple vacuum Dr. Barraquer found that rupture of the capsule occurred frequently. Working on the fact that bodies break when submitted to vibrations of greater amplitude and frequency than their elasticity permits, he has produced an instrument he calls the "erisiphake," by means of which is set up a vibrating vacuum that can be regulated in intensity. A small

electric motor works a little pump in oil which causes vibrations when producing the vacuum. These can be distinctly felt when the instrument is applied to the face or hand. The object of the erisiphake is to utilise a vibrating vacuum corresponding in amplitude and frequency, *i. e.* isochronic, with the elasticity of the lens capsule, in order that the latter may be grasped without being lacerated. (How this is estimated is not clear.) Experience has shown Dr. Barraquer that with such a vacuum ruptured capsules are much less common than with an ordinary vacuum. The intensity of the vacuum, of which there are three degrees, and the working of the motor are controlled by the assistant through a foot-pedal. The vacuum is communicated to the terminal part of the mechanism, held in the operator's right hand, by an india-rubber tube.

This terminal, or handle as it may be called, is provided with a small knob at the side, slight pressure upon which by the thumb supporting it applies or abolishes the vacuum instantaneously. The handle terminates in a platinum cannula, which has undergone many changes in its evolution, with possibly more to follow. Its hollow shaft is cylindrical and about 3 or 4 cm. long. At its free end is the hollow cup for seizing the lens. This cup is oval and somewhat triangular in shape. It is slightly curved on the flat, and its edges are smooth and rounded to avoid cutting the capsule when it is drawn up into the cup by the vacuum.

Before seeing the operations Dr. Barraquer showed us the steps of the operation with a kinematograph. This enabled us to discuss details and ask questions beforehand without interruption, and helped in knowing what special points to look out for in the actual operations.

(2) *Operation.*—Five per cent. cocaine and euphthalmine solutions are instilled for two hours to obtain maximum dilatation of the pupil. In nervous patients novocaine is injected under the upper and lower lids and over the temple. No speculum was used. An assistant held the

upper lid up with a Desmarre's retractor in one hand and the lower lid down with the thumb of the other. During the iridectomy the operator held the lower lid down by the fixation forceps (Landolt's), which were drawing the globe down, and during the application of the erisiphake he took control himself of the Desmarre's retractor and the upper lid.

The operation was performed like an ordinary extraction with a conjunctival flap. A peripheral iridectomy was done if possible, which is not always the case with such a dilated pupil. It was done before and not after the extraction as it usually is, because there is less likelihood in this method of extraction of the lens or lens-matter becoming engaged in the coloboma and perhaps causing iridodialysis.

The handle was then connected to the rubber tube and held in the right hand like a pen; its cup was passed into the anterior chamber downwards over the anterior surface of the lens and slightly behind the iris at the lower edge of the pupil. When in position, resting gently, but without any pressure, on the lens, the vacuum was turned on. The next step depended on whether there had been an iridectomy or not. If not, the lens was rotated on itself, so that the lower edge came forward, the upper passing backwards. The lens thus came out after undergoing a complete revolution on its axis. If a complete iridectomy had been done the lens was brought out as seen in the photographs, with the upper edge first. The ordinary toilet of the wound was carried out. Eserine ointment (1 per cent.) was placed in the lower fornix, the lids smeared with vaseline, and closed by lint pads, wool and sticking-plaster. They remain closed three days. All the patients get up and walk away from the table, and many of them are in their ordinary clothes, and go home at once in cab or taxi. Glasses are ordered in a fortnight. There is said to be little astigmatism.

Dr. Barraquer considers all senile cataracts are suitable,

but not juvenile or congenital, in which the zonule is too tough. He regards the zonule as *the* important structure to be considered and not the capsule. As regards the degree of vacuum, his general rule is that the older the patient and the harder the cataract the more powerful must be the vacuum. In the tests shown me the vacuum raised a column of mercury from 50 to 65 mm.

An interesting question is whether the zonule is ruptured by the drawing up of the capsule into the hollow of the cup and the consequent tightening of the zonule fibres, or is it effected by the turning over the lever movement, as Barraquer calls it, of the lens grasped by the cup? Judging by the operations I saw and the projections left on the lenses removed—bulgings of the capsule that is—I am inclined to think that the sucking up of the capsule starts the separation of the zonule and the lever movement completes it. The practical point about this is that if it is so the cup should be applied nearer the edge of the lens which it is intended to bring forward first.

(3) *Results.*—Dr. Barraquer claims that the ordinary dangers met with in cataract operations are less often met with in his. His 1000 published operation results give only 7 cases of prolapse of vitreous, 4 ruptured capsules, 3 dislocations of the lens, 4 prolapses of iris, 5 haemorrhages into the anterior chamber, and 2 infections. The resulting vision was: 0·7 to 1, 69·4 per cent.; 0·3 to 0·7, 24 per cent.; *nil* to 0·3, 6·3 per cent.; and *nil*, 0·3 per cent. Most of the cases I saw, some days old, were quiet with round central black pupils. Asked how the danger of damaging other parts, such as the iris, or sucking up other things, such as vitreous or blood, if the capsule broke could be guarded against, Dr. Barraquer said one could see such a thing beginning, and so instantly remove the vacuum that there was no real danger.

(4) *Conclusion.*—I must say that in my opinion the operation marks a great advance on other methods of extraction in the capsule, just as expression or squeezing

out the lens in its capsule was an advance upon the earlier methods of removing it by means of a scoop or spoon, inasmuch as loss of vitreous was then the rule. Suction has no doubt dangers of its own, but the principle is better. Improvements may be expected in the direction of simplification of apparatus and easier manipulation of it.

In the hospital visitors' book I saw appreciations by Fuchs and other oculists who had visited the clinic. Prof. Gallemaerts wrote after his return to Brussels, and said that at Montpellier Dr. Truc, after discussing the operation of phakoérisis, asked him which operation he would have done upon his own eye. He replied that if Barraquer did it he would have phakoérisis.

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10. *Case of filaria worm, "loa-loa," removed from eye.*

By A. E. Burroughs.

History.—Patient first visited Gold Coast 1911. Attack of malaria, and returned home for few months. Then stayed in West Africa till August, 1919 (with intervals of leave to England).

1917: Noticed "calabar" swellings in both wrists. These swellings were painful.

1918: Noticed "worm" in right eye.

No change in symptoms till March, 1921, when he consulted me for pain in right eye and headaches. I removed the worm, which I induced by warmth to appear under bulbar conjunctiva. Headaches and pain disappeared after removal of filaria.

Specimen of "worm" shown and of larvæ from the blood.

Specimens prepared and identified by Prof. Yorke, Liverpool School of Tropical Medicine.

IRISH OPHTHALMOLOGICAL SOCIETY.

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REPORTS.

Clinical Meeting held at the Royal Victoria Hospital, Dublin, on April 14th, 1921.

A number of cases were exhibited and discussed.

1. *A case of a percussion cap which had penetrated the eye of a boy, and could be seen in the retina.*

By J. B. Story.

The exhibitor asked for opinions as to treatment. The eye was quiet.

Mr. L. Werner said the best course was to leave the eye alone.

Mr. H. C. Mooney was of the same opinion.

The President (Mr. W. M. Killen) said that the text-books still advised the removal of eyes containing even small foreign bodies which could not be extracted; he

was aghast at this teaching. He had recently removed successfully a foreign body which had been in an eye eleven years.

2. *An improved form of Priestley Smith's perimeter.*

By J. B. Story.

3. *Ulcer of the cornea of an intractable type.*

By J. B. Story.

4. *Socket after unsuccessful plastic operation.*

By J. B. Story.

5. *Congenital ptosis after operation twelve years previously.*

By J. B. Story.

6. *A case of central choroiditis in a young woman.*

By L. Werner.

7. *Socket after a plastic operation.*

By H. C. Mooney.

This was a case in which a plastic operation had been performed years ago by the late Dr. Odevaine for contraction. The patient had worn an artificial eye with comfort until recently. Mr. Mooney's operation consisted in making a free incision into the floor of the orbit to form a new fornix into which he made a Thiersch graft. To retain the graft in place a piece of 2 cm. × 4 mm. drainage-tube was used. It was transfixed by two needles carrying silk with a knot at one end. The needles were then passed through the centre of the graft, which was folded over the tube. The needles, having been passed through the floor of raw fornix, were brought out on the surface of the cheek below the edge of the orbit. The graft was

then drawn into its place and the silk tied over a piece of drainage-tube. The sutures and retaining tube were removed in seven days. As there was some ectropion, Mr. Mooney regretted not having made his fresh fornix closer up to the back of the lid. The ground having been gone over before, the tissues cut into were very tough and fibrous. The result was quite satisfactory.

In the discussion Mr. WERNER said that operations for contracted socket were generally very unsuccessful; he considered Week's operation to be about the best.

The PRESIDENT warned against contraction of the bony orbit after enucleation; he advocated Mules' operation in children.

Mr. F. C. CRAWLEY thought that no eye ought to be enucleated unless fat or similar substance was put in.

Mr. DWYER JOYCE never saw a glass ball come out after a proper Mules' operation.

8. *A case of malignant lacrymal gland tumour in a girl, æt. 20 years.*

By F. C. CRAWLEY.

MISS EUPHAN MAXWELL exhibited slides of same. The growth was first noticed in 1919, and removed by Mr. Crawley in 1920. It recurred in a few months, and a further removal was done in the spring of 1921. On both occasions involvement of the bony orbit was noted. There were no known metastases. The appearance of the tumour-cells suggested an endothelial origin.

9. *A case of solitary tubercle of the iris in a young girl.*

By R. DWYER JOYCE.

10. *Bone development in the choroid in chronic uveitis.*

By Miss Maxwell.

The eye in question had been removed from a boy, æt. 9 years. It was said to have been affected since the child was a year old.

A bony shell was visible macroscopically, occupying almost the complete posterior half of the globe. There were chalky deposits on the cornea, the lens was calcareous, and the vitreous cavity was filled with an organising exudate. Under the microscope were visible masses of bone lying embedded in inflammatory tissue. The lamina vitrea, where present, lay internal to the bone-formation.

11. *Pathological specimen of lacrymal gland tumour (lymphoma) occurring in an old man.*

By Miss Maxwell.

The clinical history stated that the condition was bilateral, but more marked on the left side, the left eye being proptosed, with corneal ulceration and hyperæmia of the disc. In addition there were visible swellings in the parotid, submaxillary and pre-auricular regions, and in the groins. There were no blood changes or constitutional disturbances.

12. *A case of eclipse blindness.*

By R. H. Matthews.

The only visible change in the fundus was a small pale oval area at the macula.

13. *Several large pieces of wood removed from the same eye after an accident.*

By W. C. MacFetridge.

SCOTTISH OPHTHALMOLOGICAL CLUB.

The tenth meeting took place on November 20th, 1920, Dr. A. H. H. Sinclair in the Chair.

Dr. George Mackay, P.R.C.S.E., showed several examples of congenital abnormality: (1) Congenital anophthalmos—two children with microphthalmos out of a family of four; (2) an injury occurring in a congenitally ill-developed eye, with resulting band-shaped keratitis; (3) congenital nystagmus of unusual rapidity; (4) a case of hyperphoria after operation.

Dr. W. G. Sym showed—(1) A case of coloboma in an unusual situation; (2) fibroid changes in the fundus (? retinitis proliferans); (3) a case of immobile pupils in a young girl, of at least three years' duration; accommodation slowly becoming weaker; no stigmata of hereditary syphilis.

Dr. J. V. Paterson showed—(1) A case of tuberculosis of iris and ciliary body; (2) two cases of iridocyclitis of exceptionally long duration (with notes of a third); (3) a case of atrophy and shrinking of conjunctiva with entropion in a child of 8 years; (4) tuberculous sclero-keratitis; (5) double dislocation of the lenses outwards; (6) detachment of the retina, with a tear in the membrane; (7) injury to optic nerve head from a blow.

Dr. A. H. H. Sinclair showed—(1) Annular staphyloma of the ciliary region, with great thinning of the sclerotic and exposure of the ciliary pigment; the lens semiluxated, the iris atrophic; history of injury sixteen years previously; (2) socket after removal of a wire support, which had been introduced after enucleation; (3) persistent hyaloid

artery; (4) congenital fault in conjunctiva, with protrusion of palpebral portion of lacrymal gland; (5) double entropion, with fibrous changes in conjunctiva; (6) œdema of cornea.

Dr. Cameron showed—(1) A case of tumour of the eyelids recurring after removal sixteen years previously; (2) injury to the right eye; the left eye showing signs of (? sympathetic) inflammation, though the injured eye has remained quite quiet.

Dr. Traquair showed a successful operation for relief of hyperphoria, which had been causing much annoyance.

Dr. Leask (Glasgow) showed a new pattern of irrigator.

OPHTHALMOLOGICAL SOCIETY OF EGYPT.

1920 21.

REPORTS.

1. *Three cases of streptothrix infection of the conjunctiva.*

By Dr. Bakly.

Streptothrix infection of the conjunctiva is a very rare disease.* It is not mentioned in any text-book of ophthalmology or bacteriology. Dr. Sobhy Bey reported one case to the Ophthalmological Society of Egypt in 1915, published in the Bulletin of that year, and it seems to be the first case ever reported. I was fortunate to recognise three cases of this disease; their diagnosis was verified, or rather given, by the pathologist.

The first case, in a young boy, æt. about 13 years, was seen by me with Dr. Khairat in the end of May, 1919, in Beni Suef. His right eye was injected and his left eye was found to be infected with streptothrix. I left Beni Suef soon after that date, before taking a specimen for laboratory examination. This was done by Dr. Migally and the pathological report confirmed the diagnosis. No further notes were written about this case.

The second case, in a young lady æt. about 22 years, was seen by me and Dr. Mahmoud Zaki in Minia in the beginning of September, 1919. Her right eye was swollen and affected with mucopurulent conjunctivitis. Morax-

* See Ann. d'Oculist. June 1901. "La conjonctivite pseudo-membraneuse" by Morax and Gerhardt.

Axenfeld diplobacillus was the causative micro-organism. This same eye was found to be infected with streptothrix.

The third case, in a young girl æt. about 5 years, seen by me in Abnub in the end of December, 1920. She attended the hospital for trachoma and her left eye was found to be infected with streptothrix.

In other respects the three cases agree in every detail.

Symptoms.—The infection gives rise to no acute inflammation, irritation, discharge nor pain. Being hidden under the upper lid it is not seen by the patient's friends or family, and the patient comes for some other cause. Consequently the *duration* of the disease is not known.

Physical signs.—On raising the upper lid and ordering the patient to look well down, the upper and inner quadrant of the bulbar conjunctiva and fornix is seen to be congested and pinkish. Small yellowish hard nodules, slightly larger than a pin's head, are seen in this pinkish area of the conjunctiva. They are easily movable over the sclera and differ in number from five to twelve. The lower canaliculus is found free from any concretions. One eye is usually affected with the disease and young persons, male and female, are liable to get the infection.

Pathology and bacteriology.—That the disease is due to a streptothrix infection Dr. Bobby has no doubt. He deduced from his arguments that the organism in question is most probably of the *Actinomyces bovis seu hominis* variety.

Streptothrix is found on the normal conjunctiva and forms the concretions which occur in the lower canaliculus. Accurate classification is still wanting, and further exact examinations by means of cultures are necessary to settle the great discussion about it. It has only slight pathogenicity for animals, which explains the rarity of the disease. Injected under the conjunctiva small nodules developed in which the organisms continued for a long time (see Axenfeld, *Bacteriology of the Eye*).

The parasitic foci lie mostly in the sub-conjunctival tissue. The details of the pathological changes that

occur are well described by Dr. Sobhy in the Bulletin of 1915, which I need not repeat.

Prognosis and treatment.—I did not try any special kind of treatment. In my second case, after excising a piece of the infected conjunctiva with some of the nodules I observed, to my astonishment, after about a week, that all the remaining nodules had disappeared. The third case, a recent one, I intended to show to the Society here, but to be sure of my diagnosis I excised a piece of the infected conjunctiva and sent it to the pathologist, who confirmed the diagnosis. A week after I observed that the remaining nodules had disappeared also in this case, so that I found it useless to bring the case up, as there is nothing to see in her eye now.

A favourable end was also the result of Dr. Sobhy's case, but in his he excised all the infected area of conjunctiva. In my cases the nodules were more numerous and only a few of them were excised; the remaining were seen on the successive days after the operation, and did not disappear until after some days. What causes their disappearance one cannot tell, but I may remind you of two such examples in general surgery. Bilharzic papillomata of the colon are said to disappear if the colon is opened and few of the papillomata snipped off. Opening the abdomen in tubercular peritonitis causes the tubercles to disappear.

Dr. Sobhy Bey said: The first case I have described of this nature was in 1914 and I then made the diagnosis of actinomycosis. In the description to my first case I said that the fungus did not take the Gram stain. Well, I am wrong in this, and with the help of Prof. Morax, in Paris, the fungus took the Gram stain. Moreover Prof. Morax explained my failure in cultivating the organism by its capriciousness for anaërobic media when first obtained. This advice will be followed in the next investigations, and I ask my colleagues to send the cases they meet with to the laboratory for cultures and not the fixed organisms. In reply to Dr. M. T. Sadek, I say that

many cases of streptothrix were and are published in the literature, with the difference that these cases are not similar to mine either in the clinical description or in the formation of the hyaline zone as seen in the tissues (refer to my paper published in the Bulletin of 1914).

Dr. SADEK said: The case of streptothrix infection of conjunctiva reported by Dr. Sobhy Bey in 1915 is not, as was stated by Dr. Bakly, the first ever reported. Liégard and Landrieu (*Ann. d'Oculist.*, vol. cxlvi, p. 418) reported a case of conjunctivitis in which a streptothrix was found in the direct smear and also in culture. I may be allowed to quote here their description of the case, as it is of some interest. The patient was a woman, æt. 62 years, much given to the use of face powder, which may have been the origin of the organism found. She complained of irritation in the right eye of three or four weeks' duration, accompanied by an abundant secretion of muco-pus and a feeling of grit under the lids. She had suffered on and off for twelve years, but the present attack was the worst she had experienced. Vision was good. On examination there was a slight marginal blepharitis, edges of lids red and thickened, the skin at angles of eye red and caruncle of dark red tint. The palpebral conjunctiva was injected, and there was a quantity of muco-pus. Cornea and lacrymal passages normal.

Smear stained by Gram's method showed:

(1) Numerous dots, Gram-positive, resembling micrococci, some singly, others in thick masses. (2) Long thin bacilli, often in chains of two or three elements. (3) In places long fine filaments like the mycelium of a fungus, some of which looked like chains of streptococci; others showed clear spaces separated by darkly-stained granules, while some were matted together. In other preparations lateral filaments were seen, ending in single granules or bunches of granules, darkly stained somewhat like spores.

Cultures were taken and incubated at 37° C. Growth

was obtained on several of the media used, and slides when stained showed filaments and dots very similar in appearance to those seen in the direct smear. The organisms were found to belong to the streptothrix group of Cohn. This group they further divided into (1) the doscomyces, which corresponds to Cohn's *Streptothrix fosterii*, and (2) the nocardia, corresponding to the *Streptothrix bovis*.

I have myself come across three cases of streptothrix of the bulbar conjunctiva during 1915 and 1919:

April 17th, 1915 (Case No. 31986): Yellowish bodies seen under bulbar conjunctiva of right eye in the part covered by upper lid near fornix and below at exposed part of bulbar conjunctiva between cornea and caruncle; masses removed under cocaine; streptothrix.

November 10th, 1919 (Case No. 59825), æt. 8 years: Yellowish nodular swelling on bulbar conjunctiva, right, around caruncle; streptothrix.

November 17th, 1919 (Case No. 59956), æt. 4 years: Yellowish swellings on left bulbar conjunctiva between inner canthus and cornea; streptothrix.

2. *Some notes on blepharitis.*

By Zacharia Matta.

Although I feel myself to have a limited experience in the subject and am junior to most of you and student to some, yet I have been encouraged to say some words about special cases of blepharitis.

These cases occur in young boys and girls with inflammation and excoriation of the nasal mucous membrane and pharyngitis, or sometimes actual enlargement of the tonsils. Dr. Tewfik was kind enough to show me some cases of this type at Barrage, December, 1919, in which tonsillectomy was performed, followed by much improvement.

These cases which I mention are different from other simpler cases of blepharitis in these respects:

(1) Their persistent nature.

(2) Their severity.

(3) That they do not respond to the routine treatment applied locally to the lids.

The Morax-Axenfeld bacillus, the specific microbe, may be either killed or washed away by painting or constant wash and application of $ZnSO_4$, or yellow oxide of mercury ointment; but fresh supplies of the same microbe lie untouched and grow at ease in the mucous membrane of the nose and naso-pharynx. This can be shown by taking smears from the nose and throat of such cases, and these smears will show easily the presence of the specific microbe.

The focus of infection most probably lies somewhere in the nasal mucous membrane, and the spread of infection takes place either through the naso-lacrymal apparatus or by contagion with the fingers. In a number of these cases the condition of the nasal mucous membrane is that of an ozæna due to congenital syphilis with the typical signs of that disease. Of course, as a constitutional cause of blepharitis in general these cases are weak, anæmic, scrofulous or tuberculous.

I mentioned that the Morax-Axenfeld bacillus is found in smears from the nose to show the relation between the affection of the eyelids and that of the nose. Another proof of the intimate connection is the improvement of the condition of the lids on applying active treatment to the nose and throat condition, together with local treatment of the lids.

The dealing with the tonsils by tonsillectomy has been beneficial, but it is a drastic measure, and is not in the domain of the oculist, and can be substituted with advantage by prolonged painting with tincture of iodine.

The nose can be douched with lotions, preferably zinc lotion, and then smearing the membrane as far as can be reached with $ZnSO_4$ ointment or yellow oxide ointment.

The local treatment of the lids does not differ from the routine treatment of constant washing with ensol and

painting with $ZnSO_4$ or yellow oxide ointments. Epilation of the lashes in very severe cases may be done, care being taken to pull the lashes along their anatomical path in order not to add to the thickening and distortion of the lid margin already caused by the blepharitis, as the follicles may be disturbed and the hairs grow in wrong directions.

These cases are not at all rare, but are frequent enough to warrant careful and early treatment.

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3. *Tarsitis following multiple early Meibomian cysts.*

By M. Sobhy Bey and M. Tewfik.

The patient, H. M—, female, æt. 25 years, presented herself at Giza Ophthalmic Hospital for treatment in February, 1921, with a swelling underneath the skin of the lower lids of some months' duration.

The upper lids showed trichiasis, and the tarsal conjunctivæ, both upper and lower, showed smooth cicatrised trachoma. One or two chalazia were present in the lower tarsus, which appeared thickened uniformly from one end to the other and of an average thickness of about 8 mm.

The right lower chalazion was opened and its cavity was found extending from one to the other. After its contents were scraped away the swelling subsided. Heisrath's combined excision operation was performed on the left lower tarsus, which was then submitted to Dr. Sobhy Bey for pathological examination. His report runs thus :

"The tarsus was fixed in Bouin's solution. The cartilage is at least 5 mm. thick and twice as broad as a normal cartilage. A section was cut horizontally along its long axis, and in it there was a cavity two-thirds of the length of the cartilage. At the innermost part of the tarsus a Meibomian cyst was seen. There were no others seen clinically. The tarsus of the R.E. was quite similar to the L. with one Meibomian at its innermost side.

"Microscopic report: Most of the acini of the Meibomian glands are normal; some of them are the seat of inflammation inside and in the tissues around. Those acini which are inflamed show hyperplasia and proliferate deeper into the tissues around than the normal ones. The nature of the cellular infiltration differs with each individual inflamed acinus. Sometimes this is mostly or wholly made up of plasma-cells, or round-cells (small lymphocytes); at other times the polymorphonuclears are present with the above-mentioned varieties and may predominate. The cells of the acini may be seen and persist in the middle of such a mass. There is plenty of connective tissue on the back of the tarsus, which is also cellular."

It is so rare to find multiple small chalazia without any clinical evidence of their presence. The uniformity of the swelling and its double nature suggest a diagnosis of syphilitic tarsitis as sometimes met with in the tertiary stage, but the patient showed no signs of that disease, the blood was negative, and the microscopic report is against it.

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4. *A case of arterio-venous aneurysm.*

By M. Tewfik.

The patient is a boy, æt. 15 years. He received a gunshot wound in and around the right eye 10 months ago, on account of which the eye was completely lost and subsequently eviscerated at Assiut Ophthalmic Hospital. He returned last month with his present condition and was sent to Giza.

There is proptosis of the orbital contents under the lids; the swelling is nodular and pulsation is visible. To touch pulsation could be felt as well as a thrill, and by auscultation a bruit could be heard. Pressure on the right common carotid reduces the swelling and pressure on the tumour itself can reduce it back to a certain extent.

The left fundus was examined and nothing abnormal was detected. His vision = $\frac{6}{18}$.

Examination of the nose shows nothing abnormal, and the X-ray report by Mr. Cooper states that there are two small shot just to the right of the middle line; one is close to the pituitary fossa, and the other further back and more to the right. No definite bony lesion seen.

I believe the case to be one of arterio-venous aneurysm due to injury of the internal carotid within the cavernous sinus by the shot in its passage back, and I think it less likely to be one of surgical aneurysm of the ophthalmic artery within the orbit.

The first recorded case was one by Benjamin Travers in 1809 read before the Royal Medical and Chirurgical Society of London as "A Case of Aneurysm by Anastomosis in the Orbit cured by Ligature of the Common Carotid Artery," and it may be remarked that this is still the operation for it. Subsequently Guthrie held the opinion as well that pulsating exophthalmos was due to aneurysm of the ophthalmic artery, but Nelaton was the first to prove by post-mortem examination that it was due to rupture of the carotid within the cavernous sinus, and this theory was subsequently corroborated by Morton in 1864. However, cases do occur of aneurysm of the ophthalmic artery, but these are comparatively rare.

Many cases of arterio-venous aneurysm are on record, about 300 in all, and it may be noted that it is usually traumatic, more often as an immediate or late complication of fractured base of the skull, and less often as a result of a direct penetrating injury such as gunshot wound, etc. Idiopathic cases, however, do rarely occur, where with diseased arteries and slight rise of blood-pressure the internal carotid ruptures within the cavernous sinus; the condition starts suddenly; one such case was published by Snowball (*T.O.S.*, vol. xxxv, p. 197).

With regard to treatment, ligature of the common carotid on the affected side was first performed and is still to-day the operation preferred. With this a clot gradually forms and obliterates the aneurysm; this is why the beneficial result may result only after an interval;

if, however, the collateral circulation establishes itself before the clot forms, the condition recurs. The collateral circulation was supposed by some to take place through the branches of the two external carotids, and hence ligation of the internal carotid was recommended, but it is more difficult to perform on account of its deep situation, and it is through the circle of Willis that the collateral circulation establishes itself, and so if some months after the first operation the condition recurs, ligature of the other common carotid is indicated. Lagrange records three such successful cases. In the one-sided operation about 70 per cent. of successes are noted.

Other methods of treatment include digital and instrumental compression of the carotid, but these rarely if ever give a lasting result: acupuncture, galvano-puncture or injections with various drugs into the swelling have been tried by some without any beneficial effect.

Dealing with the tumour directly by Krönlein's operation is, I believe, hazardous on account of the danger of hæmorrhage, and should only be thought of as a last resource.

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